User Manual

eDrive/eDrive Nitro/eDrive Aero
Laser Diode Driver and
Laser System Controller

NORTHROP GRUMMAN

User Manual

eDrive and eDrive Nitro Laser Diode Driver and Laser System Controller

CEO-UMAN-0001D

This document supports firmware version 1.6.0 and later.

NORTHROP GRUMMAN

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Cutting Edge Optronics
20 Point West Boulevard
St. Charles, MO 63301

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(eDrive, eDrive Nitro, and eDrive Aero series Laser System Controller)

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use this product only as specified. If the Equipment is used in a manner not specified by Northrop Grumman - Cutting Edge Optronics, the protection provided by the eDrive equipment may be impaired.

Only qualified personnel should perform service procedures.

To Avoid Fire or Personal Injury

Use Proper Power Cord. Use only the power cord specified for this product and certified for the country of use.

Connect and Disconnect Properly. Do not connect or disconnect cables when they are connected to a voltage source.

Ground the Product. This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded. The power cord must be connected to a properly grounded wall outlet socket.

Observe All Terminal Ratings. To avoid fire or shock hazard, observe all ratings and marking on the product. Consult the product manual for further ratings information before making connections to the product.

Do Not Operate Without Covers. Do not operate this product with covers or panels removed.

Use Proper Fuses. Use only the fuse type and rating specified for this product.

Avoid Exposed Circuitry. Do not touch exposed connections and components when power is present.

Do Not Operate With Suspected Failures. If you suspect there is damage to this product, have it inspected by qualified service personnel.

Provide Proper Ventilation. Refer to the manual's installation instructions for details on installing the product so it has proper ventilation.

Do Not Operate in Wet/Damp Conditions.

Do Not Operate in an Explosive Atmosphere.

Keep Product Surfaces Clean and Dry.

Safety Terms and Symbols

Terms in This Manual. These terms may appear in this manual:

WARNING. Warning statements identify conditions or practices that could result in injury or loss of life.

CAUTION. Caution statements identify conditions or practices that could result in damage to this product or other property.

Terms on the Product. These terms may appear on the product:

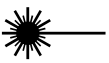
DANGER indicates an injury hazard immediately accessible as you read the marking.

WARNING indicates hazard not immediately accessible as you read the marking.

CAUTION indicates a hazard to property including the product.

Symbols on the Product or in the Manual. These symbols may appear on the product or in this user manual:

ESD:
Handle Appropriately



Laser Emission:
Use Caution

Shock Hazard:
Use Caution

Caution: Risk of
Danger
Refer to Manual

Chassis Ground

I
O

Power Switch
Position Symbols
I = On
O = Off

Preface

This manual contains operating information for the eDrive series laser system controllers. The manual consists of the following chapters:

- *Getting Started* briefly describes features of the driver and provides installation instructions.
- *Understanding Driver Functions* describes basic operations and functions of the driver: driver configuration, the Timing Engine™, triggering and gating, the power train, and operating limits.
- *Operating Basics* covers basic operating principles of the driver.
- *Application Examples* provides an overview of how to interface the driver with a computer host and how to interface a laser to the driver.
- *Communications* provides a detailed description of how to interface the driver to a computer host using the RS-232, RS-485, and Ethernet ports.
- *User Interface Reference* describes the menu system and available selection parameters.
- *Appendix A: Specifications* includes electrical and physical specifications for the driver and a key to the ordering code.
- *Appendix B: Connector Interfaces* briefly describes connector functions, pin-outs, and signaling.
- *Appendix C: Accessories* briefly describes standard and optional accessories.
- *Appendix D: General Care and Cleaning* describes general care of the driver.
- *Appendix E: CRC Calculations* contains a description of how CRC codes are calculated.

Conventions

This manual uses the following conventions:

- Front-panel buttons, knobs, and connectors appear in all uppercase letters. For example, MENU, CURRENT.
- Menu options appear with the first letter of each word in upper case. For example: Phase Delay, Pulse Width.

The ▸ symbol separates a sequence of button pushes. For example, MENU ▸ Channel Setup ▸ Pulse Width means that you push the MENU button, then push the Channel Setup soft key, and then push the Pulse Width soft key.

Product End-of-Life Handling

Cutting Edge Optronics is committed to protecting the environment. Although the driver is not included in the list of devices governed by the WEEE and RoHS EU directives, Cutting Edge Optronics will attempt to provide return service and disposal of your used equipment. When you are ready to reclaim the instrument, you must properly transfer it according to local regulations concerning WEEE equipment or ship the instrument to the Cutting Edge Optronics recycling center. You may contact Cutting Edge Optronics for the recycling center shipping address and instructions.

Contacting Cutting Edge Optronics

Phone	1-636-916-4900*
Address	Cutting Edge Optronics 20 Point West Blvd. St. Charles, MO 63301 USA
Web site	www.northropgrumman.com *Search: ceolaser*
Sales support	1-636-916-4900 x561*
Service support	1-636-916-4900 x562*
Technical support	Email: ssc30-edrive@ngc.com 1-636-916-4900 x563* 8:00 a.m. to 5:00 p.m. Central time

* After office hours, please leave a voice mail message. Outside North America, contact a Cutting Edge Optronics sales office or distributor; see the Cutting Edge Optronics web site for a list of offices.

Getting Started

This chapter provides a brief overview of the features of your eDrive product and describes how to do the following tasks:

- Install your product
- Connect your product

General Features

eDrive™ is a next generation laser system controller. It manages all critical diode-pumped solid-state (DPSS) laser parameters including diode drive current, Q-switch, and system interlocks. It is capable of driving diodes in either continuous wave (CW) or quasi-continuous wave (QCW) operating mode.

eDrive is equipped with multiple control options. An easy to use local front panel interface along with a host of digital remote control options (including compatibility with Labview*) are included.

The eDrive has been designed for maximum reliability. All system components are conservatively rated. High power circuits are physically separated from low power circuits. Minimal internal interconnect wiring reduces the risk of failure.

eDrive can be expanded to operate multiple additional diode current drive channels simultaneously by adding optional Array Interface Modules (AIMs).

The eDrive Nitro includes an integrated power supply with up to 1500W capacity and related laser system accessories.

The eDrive Aero includes an integrated power supply and a fiber pump source.

* LabView™ is the property of National Instruments Corporation.

The following list highlights key features of the eDrive.

- 40x4 character display, four soft keys, four dedicated function keys, rotary encoder for parameter selection, keylock switch, and emergency off switch
- Internal timing generation done by the Timing Engine™
- External trigger input
- System interlocks (user interlock, water flow, water level)
- High voltage, high current array control channel
- Internal power supply (option for eDrive Nitro)
- Internal RF Q-switch driver (option for eDrive Nitro)
- RS-232, RS-485, and Ethernet connectivity support
- Remote control capability
- High-power output lugs provide robust electrical and mechanical connection of your laser system to the eDrive.

eDrive Family

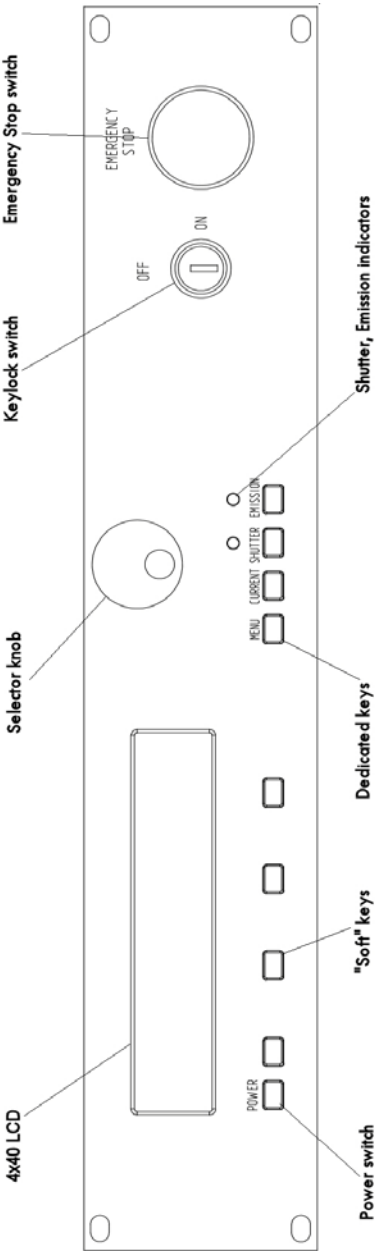
At the time of publication of this manual, the eDrive family consists of three models. They are the eDrive, the eDrive Nitro, and the eDrive Aero.

The standard eDrive provides all of the features listed in the previous section and is the baseline product.

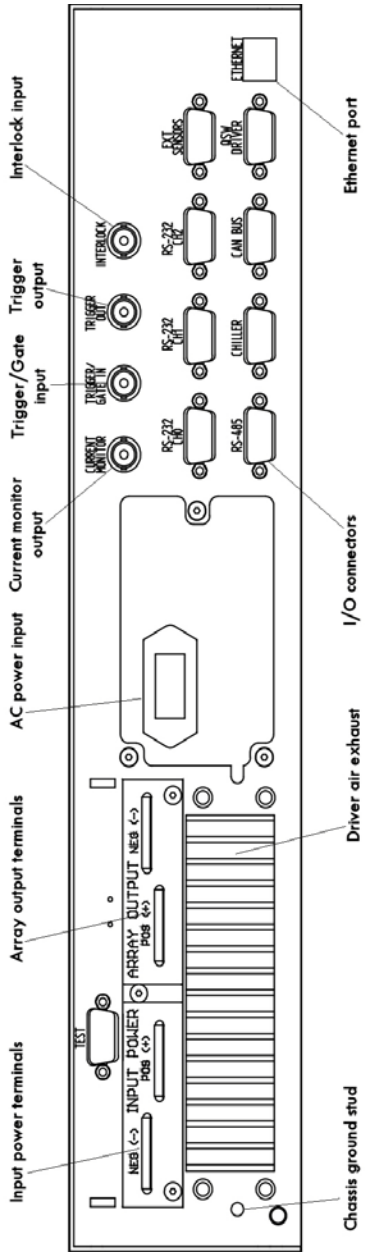
The eDrive Nitro provides the baseline features but also can include an optional internal RF driver for AO Q-switching, an optional integrated array power supply providing up to 1200W, and a laser interface connector for direct connection of your laser system to the eDrive.

The eDrive Aero provides the baseline features but also includes the RF driver, internal power supply, fiber pump source, and laser interface connector. It is designed for integrating with an external fiber-pumped gain module.

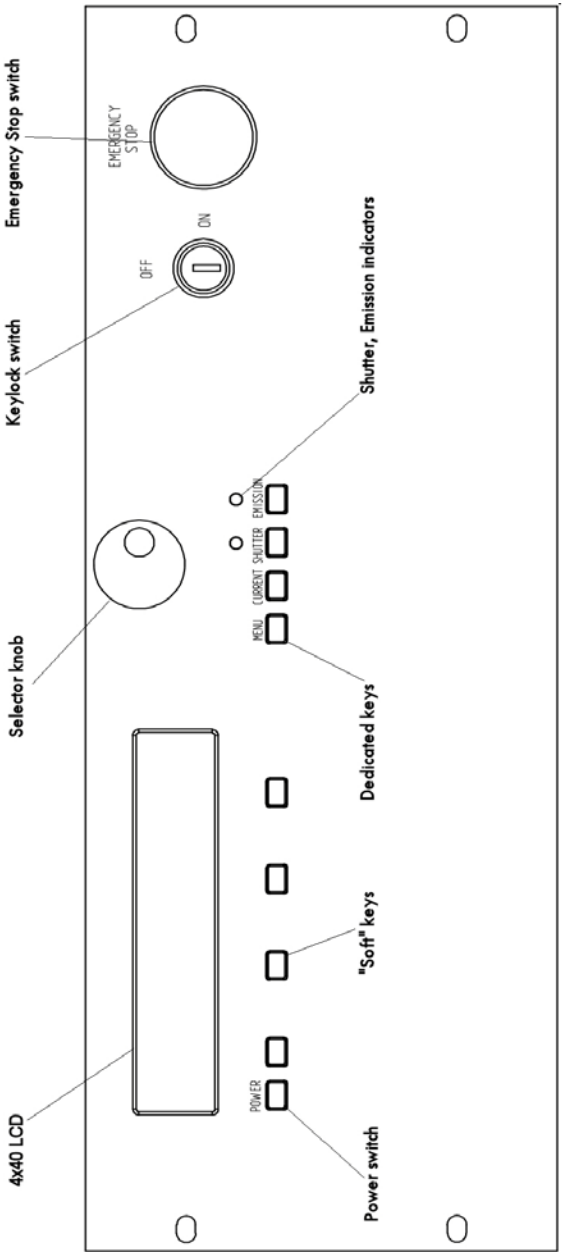
Front Panel (eDrive)



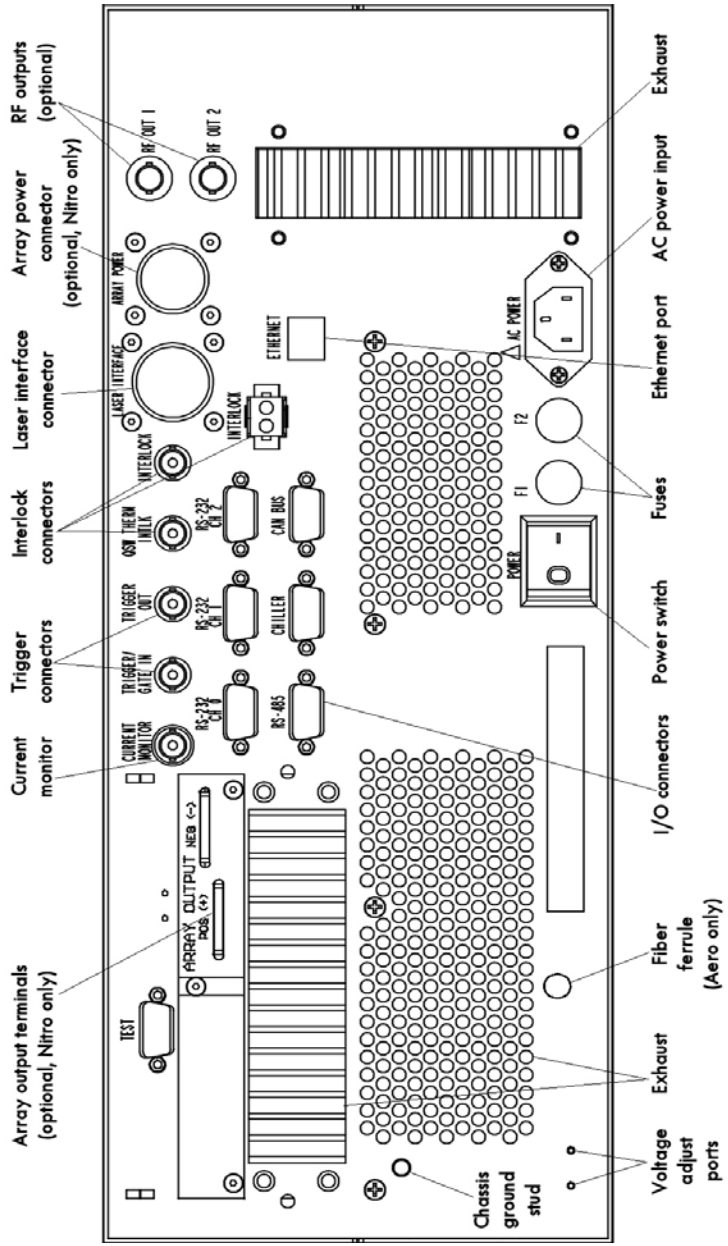
Rear Panel (eDrive)



Front Panel (eDrive Nitro and Aero)



Rear Panel (eDrive Nitro and Aero)



Installation

Input Power

Use only power cords suitable for your driver. The power cord must be connected to a properly grounded wall outlet socket. Use a power source that delivers power according to the tables shown below. Power switching is done automatically; there are no configuration switches to set for high or low power ranging. Observe recommended fuse selection for each voltage range. (Note that there are no user replaceable fuses in the eDrive (Base) Unit.) Use type 3AB Ceramic Body, Slo-Blo® fuses:

Input Power Specifications: eDrive (Base)

AC Input		Frequency
100-240 VAC	4A max.	50/60 Hz

Input Power Specifications: eDrive Nitro, Aero

AC Input		Frequency	Fuse Ratings (F1, F2)
120V ±10%	15A	50/60 Hz	T 15A 250V
240V ±10%	8A	50/60 Hz	T 8A 250V
		Fuse Dimensions: 0.25 x 1.25 inches	

Rack Mounting

The eDrive was designed to be mounted and used in an EIA-310D compliant rack. When installing the eDrive or eDrive Nitro into the rack, always install rack mounting screws into the two bottom holes of the front panel flanges first and then install screws into the top holes. This will help to minimize any potential damage that might occur to the eDrive front panel if the driver were to shift during installation.

For the 2U eDrive, it is recommended that two people install the unit into a rack if no supporting rails are used. The first person should support the driver while the second installs rack mounting screws. Rails are recommended whenever possible for more robust installation.

For the eDrive Nitro and Aero, it is recommended that two people install the unit into a rack. Supporting rails should be used. Lift the driver into place and then fasten the front panel flanges into place.

WARNING. Using the eDrive Nitro or Aero without mounting rails can result in serious damage to the driver or personal injury.

A rack mounting kit is available as an accessory. This kit includes rack mounting rails and mounting hardware.

Basic Connections

Chassis Ground Connection

A chassis ground stud is provided to facilitate connection of the eDrive chassis to the rack or building ground. The cable kit is available as an optional accessory and includes a grounding cable and hardware.

Interlock Connections

Most laser system failures occur when the system is operated without the benefit of protection features. Proper use of the eDrive system interlocks will minimize the possibility of system failure due to overheating.

Coolant Interlocks. To connect a chiller to the eDrive, first remove the coolant interlock bypass connector from the chiller connector, then attach the cable from the chiller. Be sure to observe correct pinout. Refer to Appendix B for connector pinout.

User Interlocks. The user interlock is a general-purpose interlock. It may be used to connect to a facility door switch, an optics bench-mounted emergency stop switch, or other appropriate interlock device. There is one user interlock connector on the rear panel of the eDrive and there are two user interlock connectors on the rear panel of the eDrive Nitro and Aero. One type is a BNC connector and the other is a plastic two-position connector. The BNC type connector is provided for convenience in wiring.

WARNING. The BNC connector may carry a low voltage necessary for energizing the coil of the internal interlock relay. This connector is to remain isolated from other conduction paths. Do not allow either the BNC pin or connector barrel to touch other conductive elements other than the user interlock switch.

Laser Interface Interlocks. The eDrive Nitro/Aero laser interface connector provides several system interlocks that are helpful in operating a laser system safely. These include a cover interlock, a coolant interlock, and a q-switch thermal interlock. You may route these signals to components inside your laser system such as a cover switch, a flow rate switch, and a q-switch thermal sensor switch. Refer to Appendix B for signal and connector details.

Array Power Connections

Proper application of the power wiring in the laser is critical if high performance is to be achieved. Make note of the following issues:

- Use sufficiently-heavy gauge wiring or special low-inductance wiring to connect your driver to your laser system. Recommended wire sizes are shown in the table.

Average Current	Wire Size
0 to 25A	10 AWG
25 to 50A	8 AWG
50 to 100A	6 AWG

- Be sure to use wire rated for use at voltages at least as high as the voltages which will be connected to the lug terminals.
- Do not use cables that are any longer than necessary. Long cable lengths are undesirable for two reasons: resistive losses and inductive effects.
- Be sure to minimize inductive loading on the driver output by keeping the current loop area to a minimum. This is very important for pulsed operation since it improves pulse waveform quality and enhances driver current regulation stability.
- For ultimate performance, a low-inductance Litz wire cable or flat cable can be used on the driver output circuit. Both cable types are available as optional accessories.

The eDrive power terminals are equipped with mounting holes for two-hole compression lugs. These lug types have two advantages over

standard ring terminals: contact quality and mechanical stability. Since there are two fasteners per lug and a much larger contact area, there will be lower contact resistance between the eDrive output terminal and the cable terminal. Also, the two-hole feature prevents rotation of the terminal during installation and in the event that the cable is pulled which might cause the connection to loosen.

Signal Connections

Signal connections to the eDrive are made with common connector types insuring ease of obtaining necessary parts. Custom cables can be ordered from the factory to meet your specific installation requirements. Contact the factory for a quote.

Refer to *Appendix B: Connector Interfaces* for details on the signals connectors of the eDrive series.

eDrive Coolant Connections

If using a water-cooled eDrive, the coolant water tubing must be connected to the stainless steel water connections on the back panel of the unit. Use clear 3/8" tubing with a minimum pressure rating of 180 PSI to carry the coolant water to and from the eDrive unit. These hoses should be secured onto the eDrive connections using hose clamps to ensure that they do not become loose and leak. During operation a minimum coolant flow rate of 1 gallon per minute should be maintained. To prevent damage to the unit, do not exceed a maximum pressure of 60 PSI.

It is recommended that these water connections be inspected regularly to check for leaks or loose fittings and any damaged or leaking components replaced. Also, check for any discoloration of the tubing which might indicate contamination or degradation which could lead to clogging or leakage.

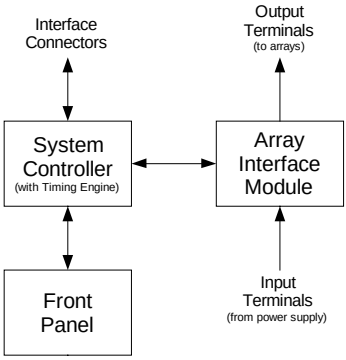
Understanding Driver Functions

This chapter contains information on what you should understand about the primary functions of your eDrive in order to use it most effectively. You will learn about the following eDrive functions:

- Driver configuration
- The Timing Engine
- Triggering and gating
- The power train
- Understanding eDrive operating limits

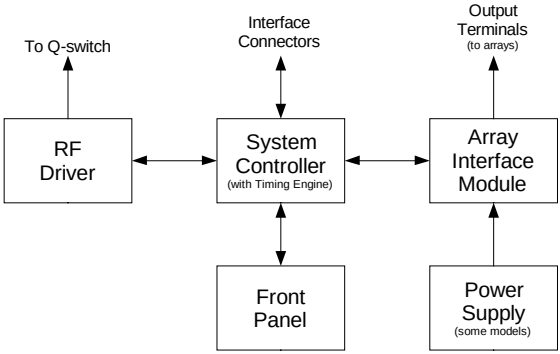
eDrive Block Diagram

The figure below shows a simple block diagram of the various functions of the standard eDrive and their relationship to each other.



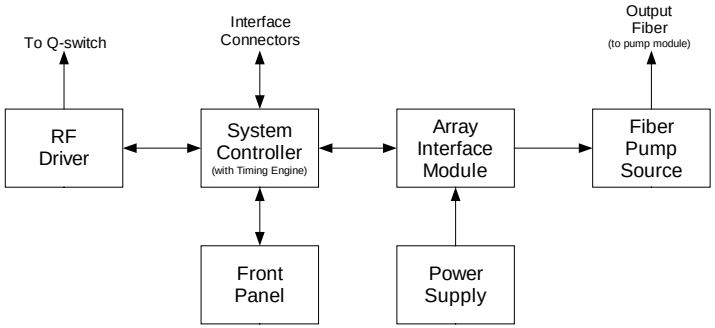
eDrive Nitro Block Diagram

The figure below shows a simple block diagram of the various functions of the eDrive Nitro and their relationship to each other.



eDrive Aero Block Diagram

The figure below shows a simple block diagram of the various functions of the eDrive Aero and their relationship to each other.



eDrive Configuration

Configuration Retention

The eDrive series uses non-volatile memory to save the user settings when the driver is powered off. These settings are restored when the driver is powered on, minimizing setup time on each use. The driver never powers on in the active driving state.

Configuring Safety Settings

The eDrive series has several safety settings that allow you to limit the extent of variability of operating parameters. These include a current limit settings and duty cycle limit setting.

Before you use your eDrive to drive a laser component, consider the use of the current and duty cycle limit settings to help prevent accidental overdrive of the laser component. Refer to the chapter *Operating Basics* for details.

Timing Engine™

The Timing Engine provides flexible control of all laser system signal timing—its like having a pulse generator built into the eDrive. The Timing Engine provides the following functions:

- Frequency control of pulsed laser system operation
- Pulse width control of the q-switch enable/trigger signal
- Pulse width control of the current output pulse
- Control of the timing of the q-switch and current pulses relative to the external trigger input and to each other
- Control of the gating function

Triggering and Gating

Modes

The eDrive can operate using an internal timing source to provide triggering or can utilize an external trigger source. The various triggering scenarios are outlined in the following table:

Mode	Description	External Trigger*	Internal Trigger Gating*	Trigger/Gate Input†
CW	▪ No triggering is used since the outputs are on continuously.	OFF	OFF	--
CW with internal q-switch triggering	▪ No external triggering is used since the trigger frequency is internally set.	OFF	OFF	--
	▪ The trigger/gate input may be configured to operate as a gate signal to halt all internal triggering	OFF	ON	Gate
CW with external q-switch triggering	▪ The trigger/gate input is configured as an external trigger supplied by the user. ▪ The eDrive does not control the frequency.	ON	--	Trigger
QCW with internal triggering	▪ No external triggering is used since the trigger frequency is internally set. ▪ Q-switching can be enabled or disabled in this mode.	OFF	OFF	--
	▪ The trigger/gate input may be configured to operate as a gate signal to halt all internal triggering	OFF	ON	Gate
QCW with external triggering	▪ An external trigger is supplied by the user. ▪ The eDrive does not control the frequency. ▪ Q-switching can be enabled or disabled in this mode.	ON	--	Trigger

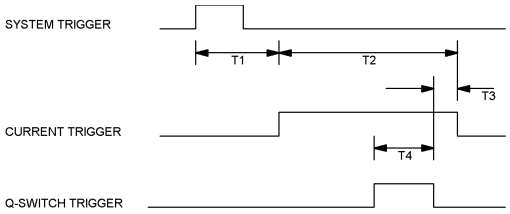
* External Trigger and Internal Trigger Gating refer to the command bits described in the section *Communications.*

† Trigger/Gate Input refers to the connector on the rear panel of the eDrive described in the section *Connector Interfaces.*

Parameters

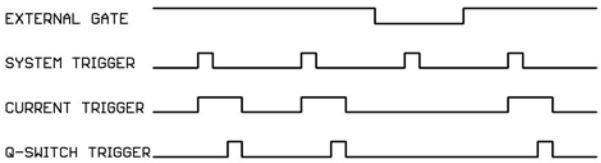
The eDrive controls the timing of the signals of the laser system. Refer to the chapter *User Interface Reference* for details on setting timing parameters.

The timing diagram below is representative of internal or external triggering. It shows the offset from the trigger signal (T1), the pulse width of the current pulse (T2), and the offset of the q-switch trigger



(T3). These parameters are typically adjusted for pulsed q-switched laser systems. For CW q-switched systems, the current pulse timing is irrelevant. (T4) is the width of the q-switch trigger pulse.

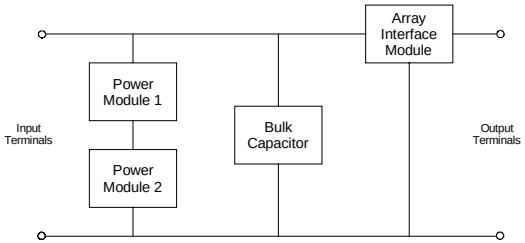
The timing diagram below is representative of internal triggering with external gating. It shows the external gating signal preventing internal triggering from occurring. The system trigger is, in this case, the internal timebase. The external gate is the signal applied to the Trigger/Gate Input. When the gate signal is low, the internal triggers do not effect the outputs. When the gate signal returns high, the triggers resume normal operation.



Power Train

The heart of the eDrive is a high-performance current regulator. This regulator provides stable current levels during operation and also switches the current on and off during pulsed-mode operation. The power provided to the current regulator can be an external source as in the case of a 2U eDrive and some 4U eDrives or an internal source as in the case of some 4U eDrives.

When the power is provided internally, it is sourced from one or two power modules that together provide the needed levels of voltage and current. This raw power is delivered to the output through the Array Interface Module (AIM) of the eDrive. When the eDrive model includes integral power supplies, the power input terminals typically are removed. See figure.



In order to provide current regulation, some voltage must be dropped across the AIM. This necessitates that the power supply voltage be marginally higher than the expected output voltage. The magnitude of that margin depends upon the expected current load of the output. Refer to the section, *Operating Basics*, for details on properly setting the power supply voltage.

When operating a pulsed-mode eDrive, the average current delivered from the supply can be much less than in CW mode. The QCW-capable eDrive models contain a storage capacitor that delivers most of the actual pulse current to the arrays. During the idle phase of the output waveform, the supply charges the capacitor in preparation for the next pulse. For this operation, the average current required from the supply can be estimated from the equation

$$I_{avg} = I_{peak} * D$$

where D is the duty cycle of the output pulse waveform.

The duty cycle, D, is the percentage of the period that the signal is actively driving current. It can be calculated from the equation

$$D = PW * PRF$$

where PW is the pulse width and PRF is the pulse rate frequency of the laser.

When choosing connector contacts and wire sizes, calculate the RMS current of the pulsed waveform using equation:

$$I_{rms} = I_{peak} * \sqrt{D}$$

where D is the duty cycle of the output pulse waveform.

Understanding eDrive Operating Limits

The eDrive must dissipate any power provided by the power supply that is not delivered to the array. If the power supply voltage level is too high or the delivered current it too high, the excess power (voltage-current product) will add heat to the AIM possibly resulting in an overheating condition.

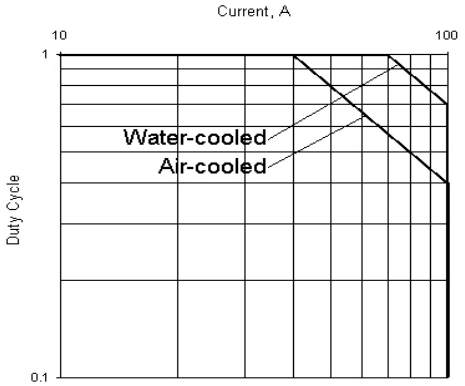
To help the user understand the limits on these parameters, two operating envelope charts for the eDrive have been provided. These charts assume that the power supplies have been properly adjusted. To properly adjust your eDrive power supply, refer to the section, *Operating Basics*. If the cooling air or water is within specification, the charts will aid in determining the trade-offs between duty cycle and array current for a fixed power supply voltage.

The eDrive can be configured with two current regulation options. One is optimized for speed and the other is optimized for power. Larger MOSFET devices can handle more current than smaller MOSFET devices but also require more settling time to stabilize. There is a trade-off between current capacity and speed. The standard eDrive is built optimized for speed. If your application requires higher power but does not require the fast transition times of the standard eDrive, please specify the higher-power configuration when ordering.

eDrive 100A

In this configuration, the typical minimum rise time is approximately 35µs. Its current vs. duty cycle operating regions are shown in the figure below. This chart was developed with a power supply set to 7V over the array voltage. Note that these numbers are maximum recommended operating limits. Your eDrive may achieve better performance but damage may occur.

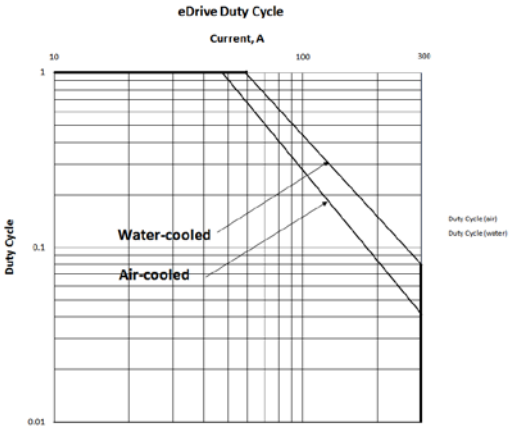
WARNING. These charts provides the maximum operating limits of the eDrive. Do not operate the eDrive outside of these limits or damage may occur.



eDrive 300A

In this configuration, the typical minimum rise time is approximately 35µs. Its current vs. duty cycle operating regions are shown in the figure below. Note that these numbers are maximum recommended operating limits. Your eDrive may achieve better performance but damage may occur.

WARNING. These charts provides the maximum operating limits of the eDrive. Do not operate the eDrive outside of these limits or damage may occur.



Operating Basics

This chapter describes basic operation of your eDrive laser system controller. In this chapter, you will learn how to:

- Power your eDrive on and off
- Use the selection knob
- Navigate the menu systems
- Connect and test proper chiller operation
- Set your eDrive to CW or QCW operation
- Use your eDrive Aero fiber pump source
- Set operating limits of array current amplitude and duty cycle
- Set your array power supply
- Control and improve pulse waveform characteristics
- Maximize output operating limits
- Configure the integrated AO Q-switch RF driver
- Connect an external Q-switch driver

Powering the eDrive on and off

Be sure to properly connect your eDrive to a suitable power source.

The eDrive Nitro and similar 4U models have a rear panel power control switch. This switch is marked with the universal switch position legends, **O** and **I.** Press the switch on the **I** side. This enables the power to be controlled from the front panel.

To power on your eDrive from the front panel, turn the key lock switch to the ON position and press the POWER switch momentarily. The eDrive will boot up and display the user interface menus.

To power off your eDrive, either turn the key lock switch to the OFF position or press and hold the POWER switch for three seconds.

Using the Selection Knob

The selection knob provides the means for quickly selecting wide range values in the eDrive. Operation is straightforward. When the display indicates, use the selection knob to make adjustment to the parameter selected.

In some cases where it is impractical to make adjustments to the values with normal selection knob behavior, the display will indicate to press the selection knob to change the scale. Press and hold the selection knob for a brief period until the scale changes to 10x or 100x. This will facilitate quick excursions in the selected value. Press the selection knob again to return to 1x mode for fine adjustments.

Navigating the Menu Systems

The eDrive series controllers provide extensive control of laser system and array parameters. To realize this capability, a set of user menus has been implemented. Refer to the section *User Interface Reference* for a detailed description of the entire menu system.

The menu system utilizes six buttons and a selection knob on the front panel. Four of the buttons are referred to as “soft”. The function of each of these four soft buttons depends on the legend displayed directly over the button.

The other two buttons, MENU and CURRENT, have specific functions that are commonly used.

The MENU button performs the following functions:

- Navigates toward the main menu. If you have navigated to sub menus within the menu system, pressing MENU will take you upward in the menu structure until you return to the main menu.
- Switches between menu modes. Press and hold MENU for three seconds to switch between the full menu system and the restricted menu system called Quick Menus. Quick Menus offers the user the most basic system options while preventing access to system configuration and setup features. The full

menus might be considered useful for the experienced laser scientist, engineer, or technician. The Quick Menus are useful for the most basic operations and may also be used to restrict access to advanced features for operators with little expertise.

The CURRENT button takes the user to a special current control and monitor display and is accessible only in the full menus. This button is ignored in the Quick Menus.

Configuring and Testing Chiller Operation

This section will step you through the operation of the eDrive and laser system.

1. Verify that your chiller is connected properly, turned on, and that the flow rate is correct.
2. Connect the coolant flow switch to the Chiller connector on the rear panel of the eDrive. See *Appendix B – Connector Interfaces* for pin designations. If your laser system includes an internal flow switch, verify that the signal connector is connected properly.
3. Power on the eDrive. If any errors are indicated on the display, isolate and correct the problem before continuing.
4. Verify the coolant flow interlock. To do this, turn off your chiller and verify that the eDrive displays a coolant flow fault. Turn on the chiller, press Clear, and verify that the error display is no longer present.

Setting the eDrive Operating Mode

To set your eDrive mode for your system configuration, follow these steps:

1. Make sure the eDrive is powered on.
2. From the main menu, select Channel Setup. Notice whether the channel is in CW mode or QCW mode. If you wish to change modes:
   a. Make sure emission is off. If not, press EMISSION.

b. Toggle the channel status to disabled. If the display does not show Channel Disabled, press Channel Enabled to toggle to the disabled state.

c. Select the desired operation mode by pressing Enable Pulsed Mode or Enable CW Mode.

d. Select Channel Disabled to toggle back to the enabled state.

WARNING. When switching between operating modes, be sure to adjust the power supply according to the instructions in this section to avoid overheating the eDrive.

Using the eDrive Aero Fiber Pump Source

Safety

The eDrive Aero is a standard eDrive with an integral fiber pump source as the power output device. Since it is a laser power source, it is important to observe safety precautions at all times during the installation, operation, and maintenance of your system.

WARNING. Do not attempt to place the eDrive Aero into active emission with no fiber optic cable attached to this connector. Damage to equipment or personnel may result.

DANGER. This connector emits visible and invisible laser radiation. Avoid direct, indirect, or scattered exposure to eyes or skin. Damage to equipment or personnel may result. This is a Class IV laser product.

When attaching a fiber optic cable to the eDrive Aero, use proper handling to prevent damage to the delicate fiber components.

Configuration

It is important to properly set the operating parameters for the eDrive Aero before beginning active emission. The eDrive Aero has been configured with the proper internal power supply. The user interface will limit the supply current to levels appropriate for the integral fiber pump source. Please refer to the section, *User Interface*, for details on

the menu system and parameter options. Refer to the user guide of the laser for specific settings required for operation.

Setting the eDrive Operating Limits

To set your eDrive to help prevent accidental overdrive, follow these steps:

1. Make sure the eDrive is powered on.
2. From the main menu, select Channel Setup ▸ Channel 1 ▸ Set Current Limit. Use the selection knob to set your maximum current amplitude to a value considered safe for the intended array. The eDrive will not allow the current amplitude to be set higher than the limit.
3. If the driver is in pulsed mode, from the main menu, select Channel Setup ▸ Channel 1 ▸ Set Duty Cycle Limit. Use the selection knob to set your maximum duty cycle to a value considered safe for the intended array. The eDrive will not allow the duty cycle to be set higher than the limit.

Setting the Power Supply

This section describes how to properly set the power supply. When selecting a power supply to use with eDrive models with no integral supply, you should select a power supply that provides a regulated voltage output with less than 0.5V ripple. Additionally, it is essential that the power supply chosen provide both overcurrent protection and short-circuit protection. For pulsed applications, be sure your supply can provide the required average power for the pulse characteristics.

External Supply

This procedure assumes that there is a load connected to the eDrive output. This output may be the actual laser module or a simulated load.

Some eDrive-series products are configured to operate with an external power supply. To set your external power supply, follow these steps:

1. Turn on the power supply.
2. Set the power supply voltage. The required power supply voltage, V_{ps}, can be approximated by summing the expected

$$V_{ps} = I_a * Z_{AIM} + V_a$$

array voltage, V_a, and the AIM dropout voltage which is calculated as the product of the expected array current, I_a, and the characteristic impedance of the AIM, Z_{AIM}, which is typically 0.08Ω. See equation.
Use the published module or array voltage from the datasheet of your laser product or, if you are using packaged diode bars, calculate the expected array voltage by multiplying the number of diode bars by the forward voltage drop. (For Cutting Edge Optronics bars, use a forward voltage drop of approximately 1.85V to 2.00V per bar.)

⚠ *WARNING.* When switching between operating modes, be sure to adjust the power supply according to the instructions in this section to avoid overheating the eDrive.

Example 1. You are driving a 12-bar array in CW mode. The expected voltage drop across the array is approximately 12 * 2.00V, or 24.00V. The AIM has a characteristic impedance of approximately 0.08 ohms. At 40A, the voltage drop across the AIM will be approximately 3.2V. The approximate total voltage required for CW operation is 24.0V + 3.2V = 27.2V.

Example 2. You have purchased a CW pump module. The datasheet for the module states that it is rated for 18V nominal operation at 30A. Set your power supply to 18V + (0.08 * 30) = 20.4V.

When operating in pulsed (QCW) operation monitor the shape of the current waveform to establish your final voltage. When testing pulsed system operation, always select a low frequency pulse rate initially (approximately 10Hz or less). This will allow you to evaluate current pulse waveform characteristics before driving significant power into your system. See Pulse Waveform Characteristics section on page 31 for more details,

3. Set the current limit on the supply to the lowest level to begin checkout.
4. Turn on your eDrive.

5. From the main menu, select Channel Setup ▸ Channel 1 ▸ Set Current. Use the selector knob to select a low current level of approximately 10A.
6. Press EMISSION. After a pre-fire state, the eDrive begins to drive the array.
7. Slowly begin to adjust the power supply current limit until you reach the 10A expected drive level.
8. Continue to increase the current amplitude settings on both eDrive and power supply until the desired current level is achieved.
9. Press EMISSION to return the eDrive to the standby state.

⚠ *WARNING.* For safety purposes, the power supply should incorporate fusing or internal overcurrent protection circuitry on the DC output voltage to be connected to the input of the eDrive equipment, in order to provide protection against faults or short circuits. This protection circuitry should be set to *disable* the output of the power supply if the output current exceeds the eDrive current limit. Overcurrent protection circuitry which utilizes a current fold-back protection could result in damage to the diode arrays as it prevents the eDrive from properly regulating the diode current.
Refer to the specifications table for information on the maximum allowable compliance voltage and maximum allowable operating current for the eDrive model being used. These limits should be set to agree with the limits provided by the power supply protection circuitry.

Internal Supply

This procedure assumes that there is a load connected to the eDrive output. This output may be the actual laser module or a simulated load.

Some eDrive models are configured with an internal power supply. For these models, the voltage and current rating of the supply already were configured to be close to the array being driven and therefore the array voltage and AIM dropout voltage have already been accounted for. However, it may be necessary to adjust the supply for your particular system or to achieve optimal performance.

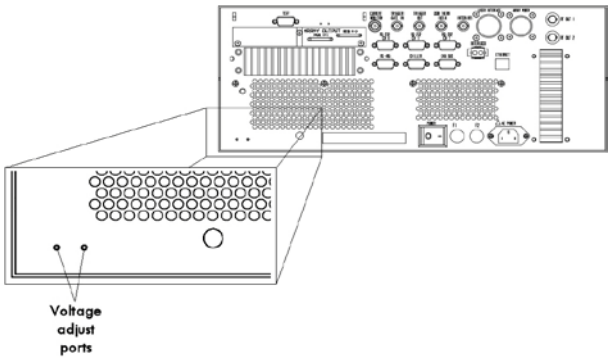
To set the internal power supply, follow these steps:

1. Turn on your eDrive.

2. From the main menu, select Channel Setup ▸ Channel 1 ▸ Set Current. Use the selector knob to select a nominal current level for your array or laser.
3. Press EMISSION. After a pre-fire state, the eDrive begins to drive the array.
4. Monitor the set and sensed current displayed on the eDrive front panel. They should track each other to within 2% or less.

If the eDrive fails to reach the commanded current amplitude level, it may be necessary to increase the supply voltage slightly. The eDrive models with internal power supplies are adjustable by approximately ±4%. Adjust the supply voltage by continuing with the steps below.

5. Carefully position the eDrive to allow easy access to the rear panel.
6. Locate the voltage control access ports on the rear panel as shown in the figure.



7. Using a plastic adjustment tool, turn one or both of the controls clockwise to achieve higher supply voltage. Note that some eDrives may have only one power module and only one control may be operational. Monitor the sensed current on the eDrive front panel. As the power supply voltage is increased, the sensed current should continue to rise until it reaches the set current level. When this occurs, turn the setting one more turn to provide a small additional margin.

CAUTION. Using an electrically-conductive adjustment tool could result in personal injury or equipment damage. Do not insert electrically-conductive tools into the openings of the enclosure of any eDrive model.

8. Press EMISSION to return the eDrive to the standby state.

WARNING. Operating the eDrive with the load improperly connected or short-circuited can result in damage to the load and the eDrive. Whenever a new load connection is made or when there is a possibility that the load connection may have changed, it is advisable that a brief test be made operating the driver at a low current setting of less than 1.0 Amp. This will allow testing the connections prior to operation at high current levels which could result in excessive power dissipation on the eDrive.

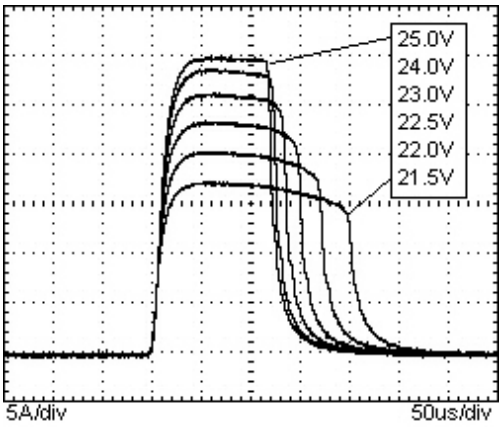
Pulse Waveform Characteristics

Using the power supply adjustment procedures outlined above will assist you in obtaining the best operating point for your eDrive and laser. For ultimate performance, waveform characteristics of the current pulse should be analyzed to make the final adjustments.

To monitor the current pulse characteristics, connect an external clamp-on current probe to the eDrive output or connect a BNC cable to the current monitor output. Connect either the current probe or cable to an oscilloscope. Follow the procedures outlined above for setting the power supply.

Waveform Characteristics and Supply Voltage

The figure below shows the current pulse waveform characteristics for various power supply voltage settings. The load is a 12-bar array and the eDrive is set to deliver a 30A pulse to the load. The oscilloscope is set for 5A/div vertically and 50.0µs/div horizontally. Set the voltage lower than the expected load voltage. Increase the voltage in increments of 1 volt until the waveform looks flat. Refer to the oscilloscope graph below.



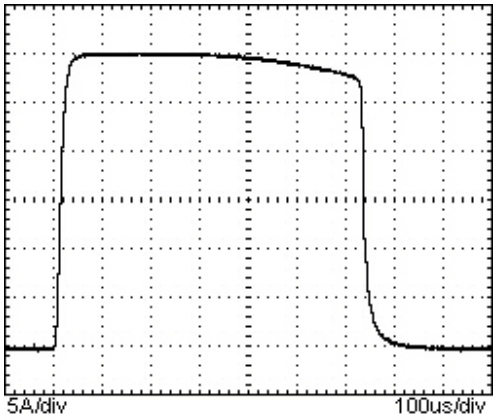
Note that when the power supply voltage is set at too low amplitude, the current pulse is weak, far below its commanded level, and longer duration than anticipated. As the supply voltage is increased to the array voltage and beyond, the current pulse amplitude reaches its commanded level of 30A and the current pulse width reaches its commanded duration. The shape of the waveform becomes flat at its maximum amplitude and exhibits good transient characteristics.

Since the array consists of 12 bars, the expected array voltage is approximately 12 * 1.8V, or 21.6V. However, since the eDrive requires some margin over the array voltage, in this case 3.4V, the desired waveform characteristics are not realized until the supply voltage reaches 25.0V.

Waveform Characteristics and Pulse Width

The figure below shows the current pulse waveform characteristics for a long current pulse. The load is a 12-bar array and the eDrive is set to deliver a 30A pulse to the load. The oscilloscope is set for 5A/div vertically and 100.0µs/div horizontally.

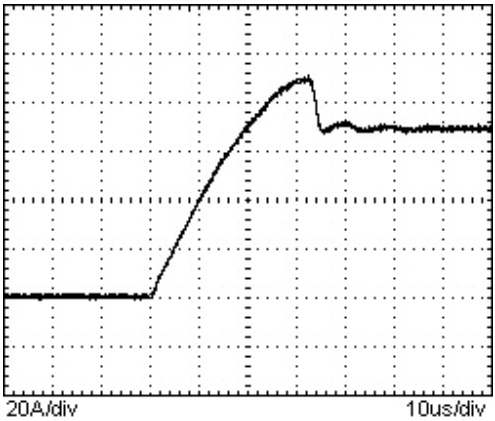
Note that the amplitude of the pulse begins to decrease at approximately 300µs from the leading edge. This results when the internal capacitor inside the eDrive is drained below the minimum charge to maintain the current amplitude. The power supply cannot respond quickly enough to the change in current. If this waveform characteristic is unacceptable, it may be necessary to add another capacitor external to the eDrive. Contact the factory for ordering information.



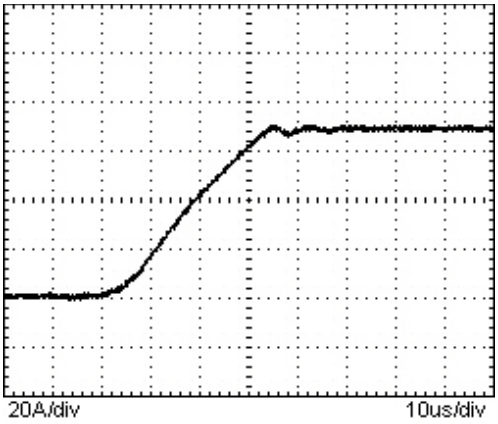
Waveform Characteristics and Standard Hookup Wire

The figures below show the rising edge characteristics of a current pulse waveform. The load is a 25-bar array and the eDrive is set to deliver a 70A pulse to the load. The oscilloscope is set for 20A/div vertically and 10.0µs/div horizontally. The hookup wire connecting the eDrive to the array is over 5m long and consists of two 6AWG wires. The external loop area of the current path is not well controlled and is estimated at approximately $0.1m^2$.

In the first figure, the eDrive is not set to use slew rate limit control but rather is switching as fast as possible. Note that the current waveform overshoots the target of 70A by 20A resulting in a peak of 90A. The eDrive quickly compensates by regulating the current to the commanded 70A amplitude but the violation has already occurred. This type of waveform characteristic typically occurs with high current amplitudes and poorly-controlled inductance on the array hookup wire.

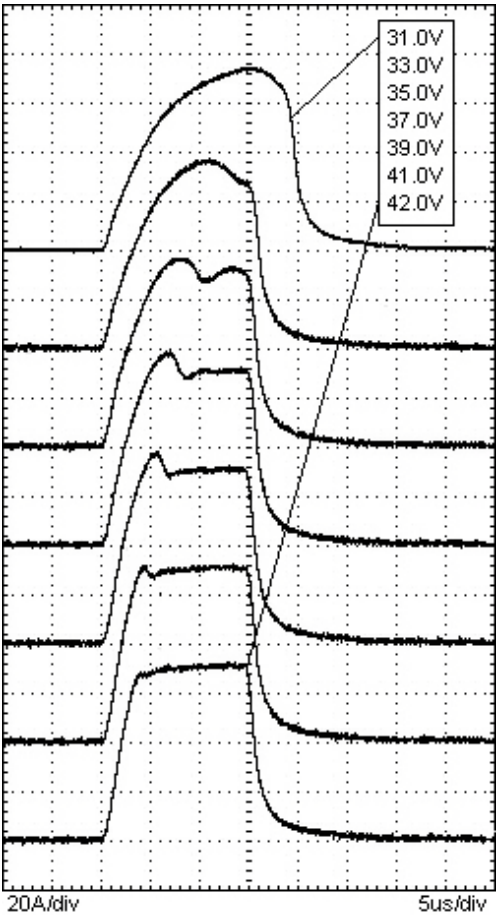


In the second figure, the eDrive has been set to slew rate limit control. This feature limits the rise time to 40μs for configurations where special wiring or routing are not options. Note that the current waveform overshoots the target of 70A but the amount of overshoot has been significantly reduced.



Waveform Characteristics and Controlled Hookup Wire

The figure below is an oscillogram montage showing the characteristics of a current pulse waveform with varying supply voltages. The load is a 14-bar array. The eDrive is specially-configured at the factory for very fast rise time operation. (Consult factory for ordering information.) It is set to deliver a 70A pulse to the load.



The oscilloscope is set for 20A/div vertically and 5.0µs/div horizontally. The hookup wire connecting the eDrive to the array is

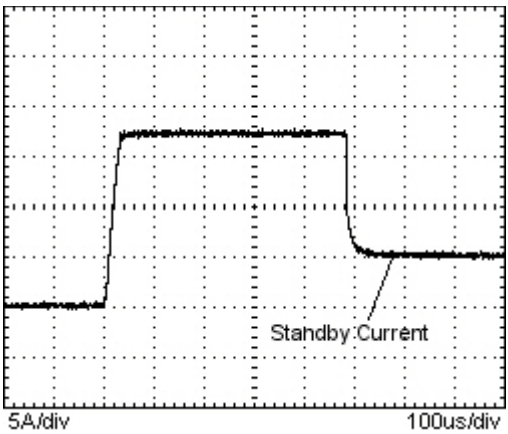
over 6m long and consists of very low inductance Litz wire. The external loop area of the current path is well-controlled and estimated to be approximately 0.002 m^2.

Note the change in the waveform characteristics as the voltage is increased. At the final setting, the voltage is 14-16V over the array voltage but the rise time is only approximately 4µs.

These oscillograms demonstrate the importance of properly adjusting your power supply to meet the conditions of your laser or diode array for optimal performance. The voltage should be set high enough to obtain proper pulse waveform characteristics. The voltage should be set low enough to allow for the broadest operating envelope without overheating the eDrive.

Waveform Characteristics and Standby Current

Normally, the current between pulses is zero. In some cases, however, it is desirable to continue to pass some current through the laser. To achieve this, the eDrive can deliver a stand-by current to the laser. This might be used to minimize thermal shock or to achieve the fastest possible turn-on times. To set a stand-by current, from the main menu select Channel 1 ▸ Set Standby Current. Enter a value that is below optical threshold so that the laser does not lase but stays warm. A value between 3A and 8A is typical. The oscillogram below shows the stand-by current that follows the first current pulse after EMISSION is pressed. Note that the current before the pulse is 0A.

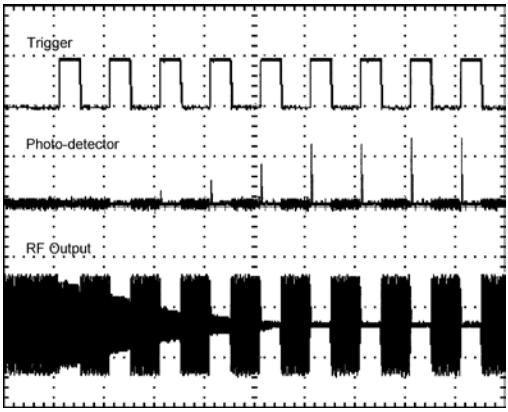


Configuring the Integrated AO Q-switch RF Driver

The eDrive Nitro and Aero have a built-in RF driver for AO Q-switching with proprietary first pulse suppression (FPS) control.

Overview

The figure below shows a typical Q-switching function. The top trace is the trigger signal, the middle trace is the optical output pulse measured with a photo detector, and the bottom trace is the output from the Q-switch RF driver. Notice how the optical output power increases



with each successive pulse as the FPS function opens the Q-switch crystal.

FPS is used to eliminate the first powerful pulse that results from an over-energized laser gain medium or cavity when lasing has been held off.

FPS Parameters

The eDrive Nitro and Aero Q-switch function is very flexible and supports control of the following parameters:

1. Q-switch trigger frequency. This parameter is the frequency at which the q-switch trigger occurs.

2. Q-switch window width. This parameter is the width of the gap in the RF modulation envelope.

3. FPS delay. This parameter is the amount of time without pulse activity that is required in order to trigger a first pulse suppression event.

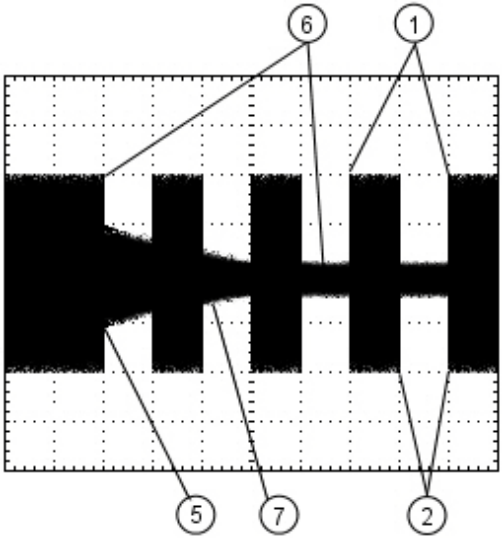
4. Q-switch RF power. This parameter sets the amount of RF power that is delivered to the q-switch during a nominal pulse. This level allows for advanced power control without adjusting the current output amplitude.

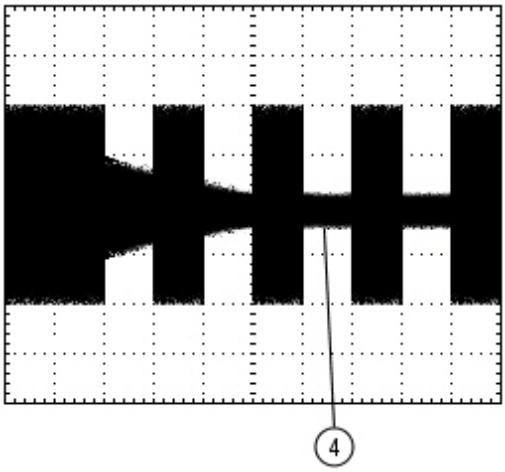
5. FPS start power. This parameter sets the amount of RF power that is delivered to the q-switch at the start of a first pulse suppression event.

6. FPS window length. This parameter sets the duration of the RF modulation waveform that occurs during a first pulse suppression event.

7. FPS modulation type. This parameter sets the shape of the RF envelope that occurs during a first pulse suppression event.

Some of these parameters are identified graphically in the figures below.





FPS Power Control

Utilizing the advanced Q-switch power control feature, the eDrive can control the optical power of the laser system without changing the array current. It does this using the Q-switch as a continuously-variable optical gate rather than just an on/off switch. (Patent pending). Notice the difference between the RF amplitude in the two oscillograms below and the previous one. The image below shows a significant amount of RF energy in the Q-switch windows even after FPS has completed. This extra RF energy will hold off part of the laser power resulting in reduced optical output.

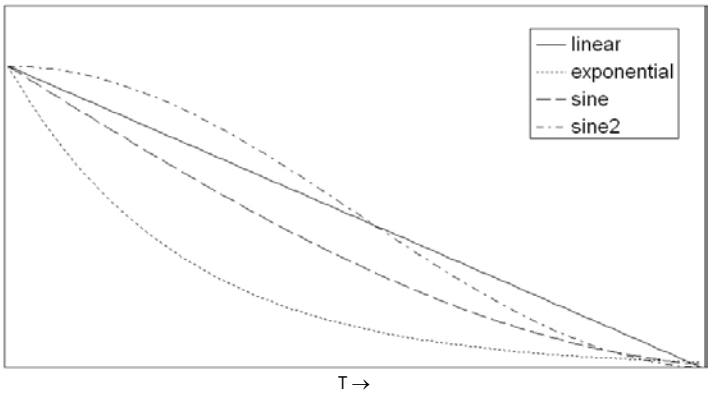
By manipulating the various parameters, you can achieve a configuration that is particularly tuned to your application.

FPS Modulation Type

The FPS modulation type, or envelope (see item 7 above), defines a decay function that is one of the following function types:

- Linear
- Exponential
- Sine
- Sine Squared

These function types may be helpful in fine-tuning the FPS operation of your laser system. For most applications, the linear function is recommended.



Connecting an External Q-switch Driver

The eDrive provides an interface to support connection of an external Q-switch driver. This external driver may be an acousto-optical driver, an electro-optical driver, or other a driver or controller of another type.

There are five signals in this interface. Please refer to the section *Q-switch Driver* in the chapter *Connector Interfaces* for a signal description.

This interface provides the enable, trigger, first pulse suppression, and reset signals that are needed by a typical external device in order to q-switch a laser. Consult the factory for details on connecting your specific q-switch device.

Application Examples

This chapter describes applications demonstrating how to use your eDrive in various laser system configurations. You will learn how to implement these functions in your laser system:

- Controlling an eDrive with a computer
- Configuring your laser system to connect to the eDrive

Controlling an eDrive with a Computer

The eDrive has built-in remote control capability using the serial ports or Ethernet interface. Custom software, LabView™ drivers, or Active-X and DCOM Modbus drivers can be used to communicate with the eDrive.

Using the Serial Port

To set up an automated control system with a local PC using the serial port, connect the eDrive to the serial port on the PC using a standard M-F 9-pin serial cable (see 88-019-10 in *Accessories*).

For details on the protocol, refer to the chapter *Communications*.

For details on setting the serial port configuration, refer to the chapter *User Interface Reference*.

When setting up the system, you may want to use the loop-back mode of the eDrive serial port to verify proper hardware setup. In this mode, the eDrive serial port simply echoes all data it receives. This can be helpful in determining that you have a properly-connected serial link and eliminates the added layer of complexity that the communications protocol requires.

Using the Ethernet Interface

To set up an automated control system with a networked PC using the Ethernet interface, connect the eDrive to the same network the PC is on using a standard Ethernet cable, type EIA/TIA-568A (see 88-019-10 in *Accessories*). Connect the eDrive to the network just as you would a PC using a hub or switch. (Note that it is possible to connect the eDrive to a PC directly using Ethernet but you will require a special cross-over cable.)

For details on setting the Ethernet interface configuration, refer to the chapter *User Interface Reference*.

When using Ethernet, you must have an IP address available for the eDrive. This can be assigned automatically by a DHCP server on the network or you may assign one manually. You will need to have an IP address and subnet mask for the eDrive and a gateway address. Check with your network administrator for help with these parameters.

When the eDrive is setup on the network as a DHCP-configured node, and if your DHCP server supports network node naming using DHCP Options 12 and 15, then the eDrive will request and use a network name. This network name is formed by joining the string “edrive” with the three-digit eDrive address set in the Ethernet Setup Menu. For example, if you set the Ethernet address with the “Set Address” option (not to be confused with the “Set IP Address” option) to a value of “5”, then the network name would be “edrive005”.

To test the network connection to the eDrive, select Utility Functions ▸ System Status ▸ Sys Ctrl. Press -More- until the assigned DHCP address is revealed. Record this address for reference.

At the computer command shell, type:

```
ping –a <ip_addr>
```

where <ip_addr> is the DHCP-assigned address recorded above. If the ping command indicates replies have been received, then the connection is validated.

If your DHCP server provides the network name function support, and if you have set the channel address, then you also may be able to type:

```
ping –a edrive<addr>
```

where <addr> is the address set as described above.

The listing below shows an example session. As you can see in the listing, the DHCP server has assigned a network name of “edrive005.domain.com” to the eDrive.

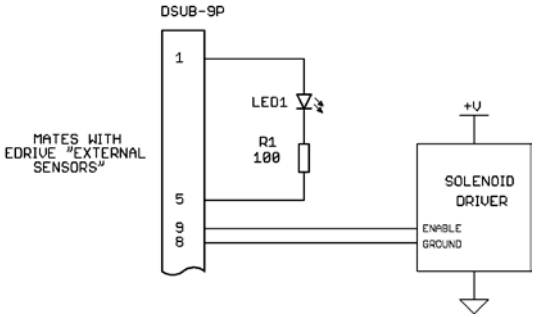
```
C:\>ping -n 1 -w 20 -a 192.168.1.34

Pinging edrive005.domain.com [192.168.1.34] with 32
bytes of data:

Reply from 192.168.1.34: bytes=32 time=6ms TTL=255

Ping statistics for 192.168.1.34:
Packets: Sent = 1, Received = 1, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 6ms, Maximum = 6ms, Average = 6ms
```

Configuring a Laser to Work with eDrive

The eDrive provides several interfaces to support a laser.

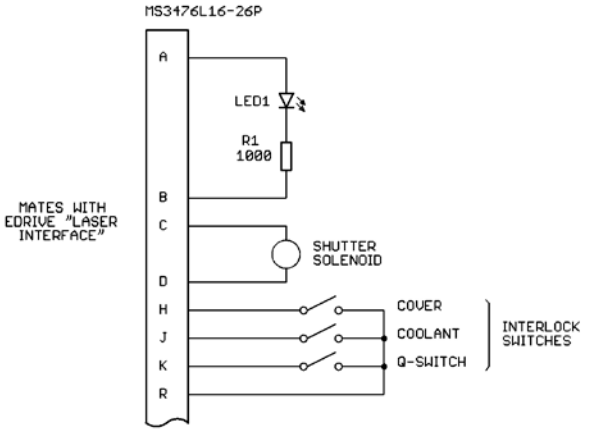
eDrive

The standard eDrive has a connector labeled “External Sensors” which includes Laser On Light and Shutter Enable Output signals. Both signals can directly drive up to 1A. The figure below shows a schematic view of how the external circuit might be configured.



eDrive Nitro and Aero

The eDrive Nitro and Aero have a laser interface connector. This interface provides numerous signal features for interfacing with your laser. Refer to *Connector Interfaces* for more details on each signal. The figure below shows a schematic representation of how the external circuit might be configured.



Communications

This chapter contains information that you need to understand to set up a communications link for remote control of your eDrive. To communicate with your eDrive effectively, you need to learn about the following functions:

- Communications overview
- Serial port configuration
- Modbus message framing and framing errors
- Ethernet port configuration
- Message function numbers, queries, and responses
- Data types accessible by each function
- Description of accessible data elements
- Using LabView™ drivers (LabView is a Trademark of National Instruments)

Communications Overview

The eDrive can interface with a host computer or controller using serial or Ethernet communications. The eDrive acts as a slave in a master-slave communications scheme.

With serial communications, the eDrive can connect to the host point-to-point using an RS-232 serial link or can be part of a multi-drop network using an RS-485 serial link. For RS-232 communications with a standard PC serial port, use a straight-through, male-to-female serial cable. See the appendix, *Accessories*, for ordering information.

With Ethernet communications, the eDrive can connect to a local area network using a standard Ethernet cable and networking equipment like a hub or switch or can connect directly to a host network card using a special network cable.

The communications protocol supported on the standard eDrive is based on Modbus, an industry standard for automated equipment. For

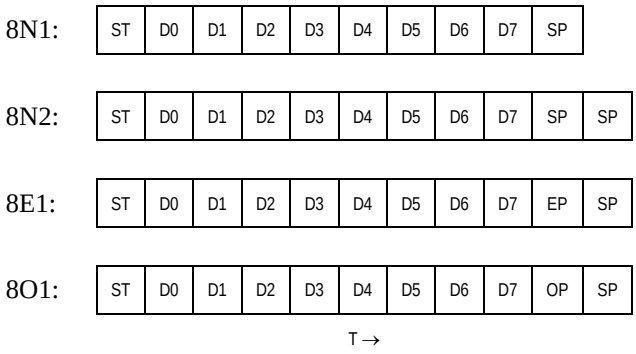
RS-232 or RS-485 interfacing, the Modbus RTU format is used. For Ethernet interfacing, Modbus TCP format is used.

Since the host is the master in the system, it initiates all messages. The eDrive responds by taking the appropriate action and returning the requested data. With serial communications, the master can address individual slaves or can initiate a broadcast message to all devices on the link. Slaves respond to messages sent directly to them.

Serial Port Configuration

The serial communications parameters can be set using the front panel interface. Refer to the section *User Interface* for an explanation of how to set the serial parameters. Serial formats allowed for communications include 8N1, 8N2, 8E1, 8O1.

Data is transferred bit-wise serial with the following formats:



ST = STart bit, Dx = Data bit, SP = StoP bit, EP = Even Parity bit, OP = Odd Parity bit

Serial Message Framing

This section describes the message framing of the protocol when using the serial port as the communications channel.

Message Start. Messages start with a silent interval of at least 3.5 character times. This is most easily implemented as a multiple of character times at the baud rate that is being used on the network.

Device Address. The first byte transmitted is the device address. Valid slave device addresses are in the range [0..247] decimal. The individual slave devices are assigned addresses in the range of [1..247]. When the slave sends its response, it places its own address in this address field of the response to let the master know which slave is responding. Address 0 is used for the broadcast address, which all slave devices recognize. This field must match the eDrive address assigned with the front panel. See Comm Setup ▸ RS-232 Channel ? Setup ▸ Set Address (where ? is either 0 or 1).

Function Number. The second byte transmitted is the function number. Valid codes are in the range [1..255] decimal but not all function numbers are used.

Data. The next group of bytes is the data field. The length of this field is dependant on the function number.

Checksum. The last two bytes are the checksum of the message. The error check value is the result of a Cyclical Redundancy Check calculation performed on the message contents. These two bytes contains a 16–bit value transmitted as two 8–bit bytes, the least-significant byte (LSB) of the CRC is appended first, followed by the most-significant byte (MSB). CRC generation is described in *Appendix G: CRC Calculations.*

Message End. Following the last transmitted character, a similar interval of at least 3.5 character times marks the end of the message. This interval can overlap with the silent interval of the next message.

A message frame is shown in the figure below:

Message Start	Address	Function	Data	Checksum	Message Stop
> 3.5 char times	1 byte	1 byte	n bytes	2 bytes	> 3.5 char times

T →

Serial Framing Errors

The entire message frame must be transmitted as a continuous stream. If a silent interval of more than 3.5 character times occurs before completion of the frame, the eDrive flushes the incomplete message and assumes that the next byte will be the address field of a new message.

If a new message begins earlier than 3.5 character times following the previous message, the eDrive will consider it a continuation of the previous message. This will set an error since the value in the final CRC field will not be valid for the combined messages.

If the eDrive detects a transmission error, the message will not be acted upon. The eDrive will not construct a response to the master. Thus the timeout will expire and allow the master to handle the error. Note that

a message addressed to a nonexistent slave device will also cause a timeout.

Ethernet Port Configuration

The Ethernet communications parameters can be set using the front panel interface. Refer to the section *User Interface* for an explanation of how to set the Ethernet parameters.

DHCP

Most Ethernet network installations include a DHCP server. This server will dynamically assign IP addresses to machines on the network that request them. If you want your eDrive to request an IP address from the DHCP server and configure its own network parameters, enable the DHCP function.

Once the DHCP function has been enabled and an IP address is assigned by the server, you can discover the IP address by using the front panel. From the main menu, select Utility Functions ▸ System Status ▸ Sys Ctrl and press -More- repeatedly until the IP address is displayed.

TCP/IP Address, Subnet Mask, and Gateway Address

If you wish to set your own TCP/IP network parameters, contact your system administrator for guidance on selecting the appropriate parameters.

Ethernet Message Framing

This section describes the message framing, or encapsulation, of the control protocol when using the Ethernet port as the communications channel. The first part of the message is referred to as the Modbus Application Protocol Header, or MBAP, and includes four fields: Transaction Identifier, Protocol Identifier, Length, and Unit Identifier. Refer to the Modbus Specification for a full description of the protocol.

Transaction Identifier. This field is used for transaction pairing. Since the message may be split over several TCP/IP packets, this field helps to reconstruct the packets into the correct order. This field consists of two bytes.

Protocol Identifier. This field is used to identify the protocol as Modbus. This field consists of two bytes. It is always set to 0x0000.

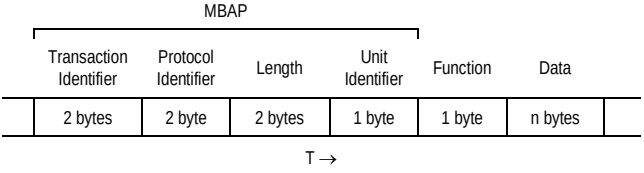
Length. This field is used to indicate the length of the message. It is a byte count of all of the following fields including the Unit Identifier, Function Code, and Data. This field consists of two bytes.

Unit Identifier. This byte is the eDrive device address. Valid slave device addresses are in the range [0..247] decimal. The individual slave devices are assigned addresses in the range of [1..247]. This field must match the eDrive address assigned with the front panel. See Comm Setup ▸ Ethernet Setup ▸ Set Address.

Function Number. This field is the function number. Valid codes are in the range [1..255] decimal but not all function numbers are used. This field consists of one byte.

Data. This field contains all the data for the message. The length of this field is dependant on the function number.

A message frame is shown in the figure below:



Function Description

The following functions are identified in the Modbus standard for communications between the master and slave devices. In each case, the query and response is shown for the serial communications method. In general, to reformat for Ethernet communications, the CRC field can be discarded, the Address field is inserted into the Unit Identifier byte which is the last byte of the MBAP, the Function field is inserted into the Function field, and remaining portion of the message is inserted into the Data field as described in Ethernet Message Framing. For details on the Modbus TCP query-response, please refer to the Modbus Specification and the Modbus Messaging Implementation Guide available from http://www.modbus.org/.

Function 01: Read Output Bits

Reads the ON/OFF status of discrete outputs in the eDrive. Broadcast is not supported. This function accesses read/write bits described later in this chapter.

Query

The format of the query is:

Address	Function	Bit Start Address	Bit Count	CRC
1 byte	0x01	2 bytes	2 bytes	2 bytes

The query message specifies the starting bit and number of bits to be read. The bit start address is the address of the first bit to be read. The bit count is the total number of bits to be read. The bit address and bit count are transmitted MSB first.

Response

The format of the response is:

Address	Function	Byte Count	Bit Data	CRC
1 byte	0x01	1 byte	n bytes	2 bytes

The response contains the bit status of the requested bits packed into bytes. The byte count indicated how many packed bytes are being returned.

The packed bits are transmitted as [n+7..n], [n+15..n+8], [n+23..n+16], etc., where n is the address of the starting bit address contained in the query.

Function 02: Read Input Bits

Reads the ON/OFF status of discrete inputs in the eDrive. Broadcast is not supported. This function accesses read-only bits described later in this chapter.

Query

The format of the query is:

Address	Function	Bit Start Address	Bit Count	CRC
1 byte	0x02	2 bytes	2 bytes	2 bytes

The query message specifies the starting bit and number of bits to be read. The bit start address is the address of the first bit to be read. The bit count is the total number of bits to be read. The bit address and bit count are transmitted MSB first.

Response

The format of the response is:

Address	Function	Byte Count	Bit Data	CRC
1 byte	0x02	1 byte	n bytes	2 bytes

The response contains the bit status of the requested bits packed into bytes. The byte count indicated how many packed bytes are being returned.

The packed bits are transmitted as [n+7..n], [n+15..n+8], [n+23..n+16], etc., where n is the address of the starting bit address contained in the query.

Function 03: Read Holding Registers

Reads the contents of holding registers in the eDrive. Broadcast is not supported. This function accesses read/write registers described later in this chapter.

Query

The format of the query is:

Address	Function	Reg Start Address	Reg Count	CRC
1 byte	0x03	2 bytes	2 bytes	2 bytes

The query message specifies the starting register and number of registers to be read. The register start address is the address of the first register to be read. The register count is the total number of registers to be read. The register address and register count are transmitted MSB first.

Response

The format of the response is:

Address	Function	Byte Count	Reg Data	CRC
1 byte	0x03	1 byte	2n bytes	2 bytes

Each register is a two-byte word. For each register, the first byte contains the high order bits and the second byte contains the low order bits. If the value stored in the register is represented by less than 16 bits, the data is right justified within the 16 bits of the register.

The data for each 2-byte register is transmitted high byte first and low byte second.

Function 04: Read Input Registers

Reads the contents of input registers in the eDrive. Broadcast is not supported. This function accesses read-only registers described later in this chapter.

Query

The format of the query is:

Address	Function	Reg Start Address	Reg Count	CRC
1 byte	0x04	2 bytes	2 bytes	2 bytes

The query message specifies the starting register and number of registers to be read. The register start address is the address of the first register to be read. The register count is the total number of registers to be read. The register address and register count are transmitted MSB first.

Response

The format of the response is:

Address	Function	Byte Count	Reg Data	CRC
1 byte	0x04	1 byte	2n bytes	2 bytes

Each register is a two-byte word. For each register, the first byte contains the high order bits and the second byte contains the low order bits. If the value stored in the register is represented by less than 16 bits, the data is right justified within the 16 bits of the register.

The data for each 2-byte register is transmitted high byte first and low byte second.

Function 05: Write Output Bit

Writes the status of an output bit in the eDrive to ON or OFF. Broadcast is supported. When broadcast, the function writes the same addressed bit in all attached eDrives. This function accesses read/write bits described later in this chapter.

Query

The format of the query is:

Address	Function	Bit Address	Value	CRC
1 byte	0x05	2 bytes	2 bytes	2 bytes

The query message specifies the bit address and the value to be written to that bit address. Transmitting a value of 0x0000 will set the bit to OFF and transmitting a value of 0xFF00 will set the bit to ON. The bit address and value are transmitted MSB first.

Response

The response is a duplicate of the query message which will be transmitted after the command has been successfully executed.

Function 06: Write Single Holding Register

Writes the contents of a single holding register in the eDrive. When broadcast, the function writes the same addressed register in all attached eDrives. This function accesses read/write registers described later in this chapter.

Query

The format of the query is:

Address	Function	Reg Address	Reg Data	CRC
1 byte	0x06	2 bytes	2 bytes	2 bytes

The query message specifies the register address and the value to be written to that register address. The register address and value are transmitted MSB first.

Response

The response is a duplicate of the query message which will be transmitted after the command has been successfully executed.

Function 11: Read Communications Status

Reads the status of the communications channel in the eDrive. The master can determine whether the messages were handled normally by the eDrive by reading the count before and after a series of messages. The eDrive's event counter is incremented once for each successful message completion. Broadcast is not supported.

Query

The format of the query is:

Address	Function	CRC
1 byte	0x0B	2 bytes

Response

The format of the response is:

Address	Function	Status	Count	CRC
1 byte	0x0B	2 byte	2 bytes	2 bytes

The normal response contains a two–byte status word, and a two–byte event count. The status word will be 0xFFFF if a previously–issued command is still being processed by the eDrive (a busy condition exists). Otherwise, the status word will be 0x0000.

The count value will indicate how many messages have been processed by the eDrive. The counter rolls over to 0 after 65536 messages.

The data for each 2-byte value is transmitted high byte first and low byte second.

Function 16: Write Multiple Holding Registers

Writes the contents of multiple holding registers in the eDrive. When broadcast, the function writes the same addressed register in all attached eDrives. This function accesses read/write registers described later in this chapter.

Query

The format of the query is:

Address	Function	Reg Start Address	Reg Count	Byte Count	Reg Data	CRC
1 byte	0x10	2 bytes	2 bytes	1 byte	2n bytes	2 bytes

The query message specifies the starting register address, the register count, the byte count (which is redundant), and the values to be written to each register addressed. All fields are transmitted MSB first.

Response

The format of the response is:

Address	Function	Reg Start Address	Reg Count	CRC
1 byte	0x10	2 bytes	2 bytes	2 bytes

The normal response returns the slave address, function code, starting address, and quantity of registers preset.

Read/Write Bits

The following table lists all read/write bits defined in the eDrive. Any bit addresses that are not in the list are reserved and should not be used. These data elements are accessible using functions 01 and 05.

Name	Addr	Description
Emission	0	OFF = Laser Emission Off ON = Laser Emission On
Enable Standby	1	OFF = The standby state is inactive ON = The standby state is active Commanding Emission to OFF will reset this bit
External Trigger	2	OFF = The eDrive will run on internal triggering from the Timing Engine™ ON = The eDrive will run on external triggering using the Trigger/Gate input
Internal Trigger Gating	3	OFF = The internal trigger is free-running ON = The Trigger/Gate input will be used to gate the internally-generated trigger pulses
Shutter	4	OFF = The shutter is always closed ON = The shutter opens when emission is active
Clear Fault	5	Set this bit to clear existing eDrive faults.
QSW Enable	6	OFF = RF AO Q-switch driver is disabled ON = RF AO Q-switch driver is enabled
FPS Enable	7	OFF = Q-switch First Pulse Suppression is disabled ON = Q-switch First Pulse Suppression is enabled
Channel 1 Enable	16	OFF = Channel 1 Array Interface Module is disabled ON = Channel 1 Array Interface Module is enabled
Channel 1 Mode	17	OFF = QCW (pulsed) operation is selected ON = CW operation is selected Note: This bit can only be changed when the eDrive is not Active and channel 1 is disabled. QCW-equipped models only.
Channel 1 Ramp Control	18	OFF = Disable current ramping for channel 1 ON = Enable current ramping for channel 1
Channel 1 Slew Rate Control	19	OFF = Slew rate control is disabled ON = Slew rate control is enabled
Channel 2 Enable	24	OFF = Channel 2 Array Interface Module is disabled ON = Channel 2 Array Interface Module is enabled
Channel 2 Mode	25	OFF = QCW (pulsed) operation is selected ON = CW operation is selected Note: This bit can only be changed when the eDrive is not Active and channel 1 is disabled. QCW-equipped models only.
Channel 2 Ramp Control	26	OFF = Disable current ramping for channel 2 ON = Enable current ramping for channel 2
Channel 2 Slew Rate Control	27	OFF = Slew rate control is disabled ON = Slew rate control is enabled
Channel 3 Enable	32	OFF = Channel 2 Array Interface Module is disabled ON = Channel 2 Array Interface Module is enabled
Channel 3 Mode	33	OFF = QCW (pulsed) operation is selected ON = CW operation is selected Note: This bit can only be changed when the eDrive is not Active and channel 1 is disabled. QCW-equipped models only.
Channel 3 Ramp Control	34	OFF = Disable current ramping for channel 3 ON = Enable current ramping for channel 3

Channel 3 Slew Rate Control	35	OFF = Slew rate control is disabled ON = Slew rate control is enabled

Read-Only Bits

The following table lists all read-only bits defined in the eDrive. Any bit addresses that are not in the list are reserved and should not be used. These data elements are accessible using function 02.

Name	Addr	Description
Fault State	0	OFF = The eDrive is not in the Faulted State ON = The eDrive is in the Faulted State
Off State	1	OFF = The eDrive is not in the Off State ON = The eDrive is in the Off State
Standby State	2	OFF = The eDrive is not in the Standby State ON = The eDrive is in the Standby State
Pre-Fire State	3	OFF = The eDrive is not in the Pre-Fire state ON = The eDrive is in the Pre-Fire state
Active State	4	OFF = The eDrive is not in the Active state ON = The eDrive is in the Active state
Channel 1 Present	5	OFF = Current Control hardware for channel 1 is not present ON = Current Control hardware for channel 1 is present
Channel 2 Present	6	OFF = Current Control hardware for channel 2 is not present ON = Current Control hardware for channel 2 is present
Channel 3 Present	7	OFF = Current Control hardware for channel 3 is not present ON = Current Control hardware for channel 3 is present
Chiller Flow Fault	8	OFF = The chiller does not have a flow fault ON = The chiller has a flow fault
Chiller Level Fault	9	OFF = The chiller does not have a level fault ON = The chiller has a Level fault
Emergency Stop Fault	10	OFF = The emergency stop button is not pressed ON = The emergency stop button is pressed
Q-switch Fault	11	OFF = The QSW fault is not active ON = The QSW fault is active
Channel 1 Fault	12	OFF = Channel 1 does not have a fault ON = Channel 1 has a fault
Channel 2 Fault	13	OFF = Channel 2 does not have a fault ON = Channel 2 has a fault
Channel 3 Fault	14	OFF = Channel 3 does not have a fault ON = Channel 3 has a fault
Front Panel Fault	15	OFF = The Front Panel does not have a fault ON = The Front Panel has a fault
Laser Cover Interlock	16	OFF = The laser cover interlock is grounded ON = The laser cover interlock is open (eDrive Nitro only)
Laser Coolant Flow Interlock	17	OFF = The laser system coolant flow interlock is grounded ON = The laser system coolant flow interlock is open (eDrive Nitro only)
Q-switch Thermal Interlock	18	OFF = The q-switch thermal interlock is grounded ON = The q-switch thermal interlock is open (eDrive Nitro only)
Q-switch Driver Thermal Fault	19	OFF = The internal q-switch RF driver is operating within safe temperature range ON = The internal q-switch RF driver has an over-temperature fault (eDrive Nitro only)

Q-switch Crystal Thermal Interlock	20	OFF = The q-switch thermal BNC interlock is shorted (safe) ON = The q-switch thermal BNC interlock is open (faulted) (eDrive Nitro only)
Q-switch HVSWR Fault	21	OFF = The internal q-switch RF driver does not have an HVSWR fault ON = The internal q-switch RF driver has an HVSWR fault HVSWR = high-voltage standing-wave ratio (eDrive Nitro only)
Q-switch High Power Fault	22	OFF = The internal q-switch RF driver does not have a high-power fault ON = The internal q-switch RF driver has a high power fault (eDrive Nitro only)
Laser Shutter State	23	OFF = The shutter output is not energized. ON = The shutter output is energized.
Channel 1 Off State	32	OFF = Channel 1 is not in the Off State ON = Channel 1 is in the Off State
Channel 1 Standby	33	OFF = Channel 1 is not in the Standby State ON = Channel 1 is in the Standby State
Channel 1 Active	34	OFF = Channel 1 is not in the Active State ON = Channel 1 is in the Active State
Channel 1 Fault State	35	OFF = Channel 1 is not in the Fault State ON = Channel 1 is in the Fault State
Channel 1 State Mismatch Fault	36	OFF = Channel 1 state does not have a fault ON = Channel 1 state has a fault
Channel 1 Comm Fault	37	OFF = Channel 1 processor communication is good ON = Channel 1 processor stopped communicating with the system
Channel 1 Hardware Fault	38	OFF = Channel 1 does not have a hardware fault ON = Channel 1 has a hardware fault
Channel 1 E-Stop Fault	39	OFF = Channel 1 is not on the emergency stop state ON = Channel 1 is on the emergency stop state
Channel 1 Comm Timeout Fault	40	OFF = Channel 1 processor communication is good ON = Channel 1 has a fault due to slow communications
Channel 1 Interlock Fault	41	OFF = Channel 1 does not have an interlock fault ON = Channel 1 has an interlock fault
Channel 1 Temp Fault	42	OFF = Channel 1 does not have a temperature fault ON = Channel 1 has a temperature fault
Channel 2 Off State	48	OFF = Channel 2 is not in the Off State ON = Channel 2 is in the Off State
Channel 2 Standby	49	OFF = Channel 2 is not in the Standby State ON = Channel 2 is in the Standby State
Channel 2 Active	50	OFF = Channel 2 is not in the Active State ON = Channel 2 is in the Active State
Channel 2 Fault State	51	OFF = Channel 2 is not in the Fault State ON = Channel 2 is in the Fault State
Channel 2 State Mismatch Fault	52	OFF = Channel 2 state does not have a fault ON = Channel 2 state has a fault
Channel 2 Comm Fault	53	OFF = Channel 2 processor communication is good ON = Channel 2 processor stopped communicating with the system
Channel 2 Hardware Fault	54	OFF = Channel 2 does not have a hardware fault ON = Channel 2 has a hardware fault
Channel 2 E-Stop Fault	55	OFF = Channel 2 is not on the emergency stop state ON = Channel 2 is on the emergency stop state
Channel 2 Comm Timeout Fault	56	OFF = Channel 2 processor communication is good ON = Channel 2 has a fault due to slow communications
Channel 2 Interlock Fault	57	OFF = Channel 2 does not have an interlock fault ON = Channel 2 has an interlock fault

Channel 2 Temp Fault	58	OFF = Channel 2 does not have a temperature fault ON = Channel 2 has a temperature fault
Channel 3 Off State	64	OFF = Channel 3 is not in the Off State ON = Channel 3 is in the Off State
Channel 3 Standby	65	OFF = Channel 3 is not in the Standby State ON = Channel 3 is in the Standby State
Channel 3 Active	66	OFF = Channel 3 is not in the Active State ON = Channel 3 is in the Active State
Channel 3 Fault State	67	OFF = Channel 3 is not in the Fault State ON = Channel 3 is in the Fault State
Channel 3 State Mismatch Fault	68	OFF = Channel 3 state does not have a fault ON = Channel 3 state has a fault
Channel 3 Comm Fault	69	OFF = Channel 3 processor communication is good ON = Channel 3 processor stopped communicating with the system
Channel 3 Hardware Fault	70	OFF = Channel 3 does not have a hardware fault ON = Channel 3 has a hardware fault
Channel 3 E-Stop Fault	71	OFF = Channel 3 is not on the emergency stop state ON = Channel 3 is on the emergency stop state
Channel 3 Comm Timeout Fault	72	OFF = Channel 3 processor communication is good ON = Channel 3 has a fault due to slow communications
Channel 3 Interlock Fault	73	OFF = Channel 3 does not have an interlock fault ON = Channel 3 has an interlock fault
Channel 3 Temp Fault	74	OFF = Channel 3 does not have a temperature fault ON = Channel 3 has a temperature fault

Read/Write Registers

The following table lists all read/write registers defined in the eDrive. Any register addresses that are not in the list are reserved and should not be used. These data elements are accessible using functions 03, 06, and 16.

Name	Addr	Description
System Frequency	0	This value represents the frequency of the internal timing engine. If channel 1 is in CW mode, this frequency is only used for Q-switch pulse generation. If channel 1 is in QCW mode, this frequency is used for pulsing of channel 1 and the Q-switch pulses are tied to the current pulse. Range: 2 to 50,000. LSB value: 1 Hz.
Q-switch Pulse Width	1	This value represents the width of the Q-switch pulse in 0.01µs increments. The eDrive rounds the value to the nearest 0.04µs value. Range: 1 to 25,000. LSB value: 0.01µs.
Q-switch Pulse Offset High	2	This value represents the timing offset of the Q-switch pulse relative to the end of the current pulse. This value is only valid when channel 1 is in QCW mode. When the offset is zero, the Q-switch pulse will end at the same time the current pulse ends. A negative value moves the Q-switch pulse before the end of the current pulse. A positive number moves the Q-switch pulse after the end of current pulse. The eDrive rounds the value to the nearest 0.04µs value. Range: -2,147,483,648 to 2,147,483,647 (limited by system frequency and pulse width). LSB value: 0.01µs. (This value is a signed 32-bit number. For this value to be properly written, write to the high word first, followed by the low word.)
Q-switch Pulse Offset Low	3	
Q-switch Power Output	4	This value represents the amount of RF attenuation imposed on the Q-switch driving signal during a Q-switch window. Range: 0 to 1000. LSB value: 0.1 percent. (eDrive Nitro only)
Q-switch FPS Start Power	5	This value represents the amount of RF attenuation imposed on the Q-switch driving signal at the beginning of a First Pulse Suppression (FPS) event. Range: 0 to 1000. LSB value: 0.1 percent. (eDrive Nitro only)
Q-switch FPS Window Width	6	This value represents the duration of the Q-switch window. Range: 10 to 1000µs. LSB value: 1µs (eDrive Nitro only)
Q-switch FPS Window Type	7	This value represents the type of attenuation function imposed on the Q-switch driving signal during a Q-switch window. Refer to Operating Basics for details. Functions: 0 = Linear, 1 = Exponential, 2 = Sine, 3 = Sine Squared (eDrive Nitro only)
Q-switch FPS Delay High	8	This value represents the FPS delay setting. This value determines the period of inactivity before an FPS event is triggered upon restart of the pulses. Range: 10µs to 500 ms. LSB value: 1µs. (For this value to be properly written, write to the high word first, followed by the low word.)
Q-switch FPS Delay Low	9	

Channel 1 Active Current	16	This value represents the current level for channel 1 when the eDrive is actively driving the array output in either CW or QCW modes. See Standby Current below. Units: amps (A). Range: 0 to 1,000. LSB value: 0.1A.
Channel 1 Standby Current	17	This value represents the current level for channel 1 when the eDrive is in standby CW or QCW mode or during the inactive portion of the QCW pulse. Units: amps (A). Range: 0 to 1,000. LSB value: 0.1A.
Channel 1Pulse Width High	18	This value represents the width of a current pulse for channel 1. It is only used when the channel is in QCW mode. Range: 10 to 100,000 (limited by the system frequency to prevent the pulse width from exceeding the period). LSB value: 0.1µs. (For this value to be properly written, write to the high word first, followed by the low word.)
Channel 1 Pulse Width Low	19	
Channel 1 Pulse Delay High	20	This value represents the delay of the current pulse of channel 1 relative to the trigger. It is only used when the channel is in QCW mode. Range: 1 to 100,000. LSB value: 1µs. When using internal triggering, the range is limited by the system frequency so the pulse ends before the start of the next trigger. When using external triggering, all external trigger events are ignored during an active pulse. (For this value to be properly written, write to the high word first, followed by the low word.)
Channel 1 Pulse Delay Low	21	
Channel 1 Slew Rate	22	This value represents the slew rate for channel 1. Range: 1 to 3000. LSB value: 1 amp/second.
Channel 2 Active Current	32	This value represents the current level for channel 2 when the eDrive is actively driving the array output in either CW or QCW modes. See Standby Current below. Units: amps (A). Range: 0 to 1,000. LSB value: 0.1A.
Channel 2 Standby Current	33	This value represents the current level for channel 2 when the eDrive is in standby CW or QCW mode or during the inactive portion of the QCW pulse. Units: amps (A). Range: 0 to 1,000. LSB value: 0.1A.
Channel 2Pulse Width High	34	This value represents the width of a current pulse for channel 2. It is only used when the channel is in QCW mode. Range: 10 to 100,000 (limited by the system frequency to prevent the pulse width from exceeding the period). LSB value: 0.1µs. (For this value to be properly written, write to the high word first, followed by the low word.)
Channel 2 Pulse Width Low	35	
Channel 2 Pulse Delay High	36	This value represents the delay of the current pulse of channel 2 relative to the trigger. It is only used when the channel is in QCW mode. Range: 1 to 100,000. LSB value: 1µs. When using internal triggering, the range is limited by the system frequency so the pulse ends before the start of the next trigger. When using external triggering, all external trigger events are ignored during an active pulse. (For this value to be properly written, write to the high word first, followed by the low word.)
Channel 2 Pulse Delay Low	37	
Channel 2 Slew Rate	38	This value represents the slew rate for channel 2. Range: 1 to 3000. LSB value: 1 amp/second.
Channel 3 Active Current	48	This value represents the current level for channel 3 when the eDrive is actively driving the array output in either CW or QCW modes. See Standby Current below. Units: amps (A). Range: 0 to 1,000. LSB value: 0.1A.
Channel 3 Standby Current	49	This value represents the current level for channel 3 when the eDrive is in standby CW or QCW mode or during the inactive portion of the QCW pulse. Units: amps (A). Range: 0 to 1,000. LSB value: 0.1A.
Channel 3Pulse Width High	50	This value represents the width of a current pulse for channel 3. It is only used when the channel is in QCW mode.

Channel 3 Pulse Width Low	51	Range: 10 to 100,000 (limited by the system frequency to prevent the pulse width from exceeding the period). LSB value: 0.1µs. (For this value to be properly written, write to the high word first, followed by the low word.)
Channel 3 Pulse Delay High	52	This value represents the delay of the current pulse of channel 3 relative to the trigger. It is only used when the channel is in QCW mode. Range: 1 to 100,000. LSB value: 1µs. When using internal triggering, the range is limited by the system frequency so the pulse ends before the start of the next trigger. When using external triggering, all external trigger events are ignored during an active pulse. (For this value to be properly written, write to the high word first, followed by the low word.)
Channel 3 Pulse Delay Low	53	
Channel 3 Slew Rate	54	This value represents the slew rate for channel 3. Range: 1 to 3000. LSB value: 1 amp/second.

Read-Only Registers

The following table lists all read-only registers defined in the eDrive. Any register addresses that are not in the list are reserved and should not be used. These data elements are accessible using function 04.

Name	Addr	Description
SC Firmware Version X	0	This value represents the firmware version of the system controller (SC). The version number is represented as x.y.z.
SC Firmware Version Y	1	
SC Firmware Version Z	2	
Front Panel Firmware Version	3	The firmware version of the front panel
SC Warranty Timer High	4	This value represents the number of hours accumulated on the warranty timer of the SC. Range: 0 to 4,294,967,295. LSB value: 1 second.
SC Warranty Timer Low	5	
EM Firmware Version X	6	This value represents the firmware version of the expansion module (EM). The version number is represented as x.y.z.
EM Firmware Version Y	7	
EM Firmware Version Z	8	
EM Warranty Timer High	9	This value represents the number of hours accumulated on the warranty timer of the EM. Range: 0 to 4,294,967,295. LSB value: 1 second.
EM Warranty Timer Low	10	
Channel 1 Firmware Version X	16	This value represents the firmware version of the channel 1 Array Interface Module (AIM). The version number is represented as x.y.z.
Channel 1 Firmware Version Y	17	
Channel 1 Firmware Version Z	18	
Channel 1 Sensed Current Flow	19	This value represents the amount of current presently flowing through channel 1. If the eDrive is in pulsed mode and active, the current reading during the active pulse will be returned. Range: 0 to 1,000. LSB value: 0.1A.
Channel 1 Power Supply Voltage	20	This value represents the power supply voltage reading for channel 1. Range: 0 to 3500. LSB value: 0.1V.
Channel 1 Temperature	21	This value represents the temperature reading for channel 1. Range: 0 to 1000. LSB value: 0.1C.
Channel 1 Current Limit	22	This value represents the current limit setting for channel 1. Range: 0 to 1,000. LSB value: 0.1A.
Channel 1 Duty Cycle	23	This value represents the duty cycle limit for channel 1. Range: 0 to 1000. LSB value: 0.1 percent
Channel 1 Warranty Timer High	24	This value represents the number of hours accumulated on the warranty timer of the channel 1 AIM. Range: 0 to 4,294,967,295. LSB value: 1 second.

Channel 1 Warranty Timer Low	25	
Channel 1 CW On Time High	26	This value represents the CW on time for channel 1 that current levels above 6A has flowed through the AIM. Range: 0 to 4,294,967,295. LSB value: 1 second.
Channel 1 CW On Time Low	27	
Channel 1 CW Power Cycle Count High	28	This value represents the CW power cycle count for channel 1 that indicates how many times current flow has been turned on and off in CW mode. Range: 0 to 4,294,967,295.
Channel 1 CW Power Cycle Count Low	29	
Channel 1 Pulsed Mode Shot Counter High	30	This value represents the channel 1 shot counter. Range: 0 to 4,294,967,295.
Channel 1 Pulsed Mode Shot Counter Low	31	
Channel 2 Firmware Version X	48	This value represents the firmware version of the channel 2 Array Interface Module (AIM). The version number is represented as x.y.z.
Channel 2 Firmware Version Y	49	
Channel 2 Firmware Version Z	50	
Channel 2 Sensed Current Flow	51	This value represents the amount of current presently flowing through channel 2. If the eDrive is in pulsed mode and active, the current reading during the active pulse will be returned. Range: 0 to 1,000. LSB value: 0.1A.
Channel 2 Power Supply Voltage	52	This value represents the power supply voltage reading for channel 2. Range: 0 to 3500. LSB value: 0.1V.
Channel 2 Temperature	53	This value represents the temperature reading for channel 2. Range: 0 to 1000. LSB value: 0.1C.
Channel 2 Current Limit	54	This value represents the current limit setting for channel 2. Range: 0 to 1,000. LSB value: 0.1A.
Channel 2 Duty Cycle	55	This value represents the duty cycle limit for channel 2. Range: 0 to 1000. LSB value: 0.1 percent
Channel 2 Warranty Timer High	56	This value represents the number of hours accumulated on the warranty timer of the channel 2 AIM. Range: 0 to 4,294,967,295. LSB value: 1 second.
Channel 2 Warranty Timer Low	57	
Channel 2 CW On Time High	58	This value represents the CW on time for channel 2 that current levels above 6A has flowed through the AIM. Range: 0 to 4,294,967,295. LSB value: 1 second.
Channel 2 CW On Time Low	59	
Channel 2 CW Power Cycle Count High	60	This value represents the CW power cycle count for channel 2 that indicates how many times current flow has been turned on and off in CW mode. Range: 0 to 4,294,967,295.

Channel 2 CW Power Cycle Count Low	61	
Channel 2 Pulsed Mode Shot Counter High	62	This value represents the channel 2 shot counter. Range: 0 to 4,294,967,295.
Channel 2 Pulsed Mode Shot Counter Low	63	
Channel 3 Firmware Version X	80	This value represents the firmware version of the channel 3 Array Interface Module (AIM). The version number is represented as x.y.z.
Channel 3 Firmware Version Y	81	
Channel 3 Firmware Version Z	82	
Channel 3 Sensed Current Flow	83	This value represents the amount of current presently flowing through channel 3. If the eDrive is in pulsed mode and active, the current reading during the active pulse will be returned. Range: 0 to 1,000. LSB value: 0.1A.
Channel 3 Power Supply Voltage	84	This value represents the power supply voltage reading for channel 3. Range: 0 to 3500. LSB value: 0.1V.
Channel 3 Temperature	85	This value represents the temperature reading for channel 3. Range: 0 to 1000. LSB value: 0.1C.
Channel 3 Current Limit	86	This value represents the current limit setting for channel 3. Range: 0 to 1,000. LSB value: 0.1A.
Channel 3 Duty Cycle	87	This value represents the duty cycle limit for channel 3. Range: 0 to 1000. LSB value: 0.1 percent
Channel 3 Warranty Timer High	88	This value represents the number of hours accumulated on the warranty timer of the channel 3 AIM. Range: 0 to 4,294,967,295. LSB value: 1 second.
Channel 3 Warranty Timer Low	89	
Channel 3 CW On Time High	90	This value represents the CW on time for channel 3 that current levels above 6A has flowed through the AIM. Range: 0 to 4,294,967,295. LSB value: 1 second.
Channel 3 CW On Time Low	91	
Channel 3 CW Power Cycle Count High	92	This value represents the CW power cycle count for channel 3 that indicates how many times current flow has been turned on and off in CW mode. Range: 0 to 4,294,967,295.
Channel 3 CW Power Cycle Count Low	93	
Channel 3 Pulsed Mode Shot Counter High	94	This value represents the channel 3 shot counter. Range: 0 to 4,294,967,295.
Channel 3 Pulsed Mode Shot Counter Low	95	

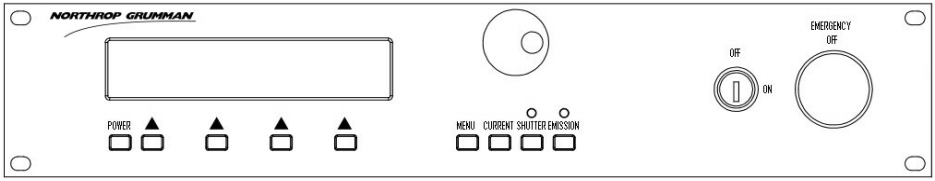
User Interface Reference

This chapter contains a reference of the front panel user interface including:

- Front panel controls
- Standard menus/displays
- Quick menus/displays
- Current monitor menu/display
- Error/fault displays

Front Panel Controls

This section provides a brief description of the front panel controls.



The front panel has the following features.

LCD

The LCD is a four line by 40 character display with backlight.

Power Control Button

The power control button under the LCD is used in conjunction with the keylock switch to power the eDrive on and off. To power on, simply press the POWER button while the keylock switch is in the ON position. To power off, hold the POWER button in for three seconds.

"Soft" Buttons

The four "soft" buttons under the LCD are used in conjunction with the text on the LCD. The functions of these buttons are determined by the text displayed over them.

Menu Button

The MENU button has several functions.

- It navigates toward the main menu. If you have navigated to sub menus within the menu system, pressing MENU will take you upward in the menu structure until you return to the main menu.
- It switches between menu modes. Press and hold MENU for three seconds to switch between the full menu system and the restricted menu system called Quick Menus. Quick Menus offers the user the most basic system options while preventing

access to system configuration and setup features. The full menus might be considered useful for the experienced laser scientist, engineer, or technician. The Quick Menus are useful for the most basic operations and may also be used to restrict access to advanced features for operators with little expertise.

See the sections below for Standard Menus and Quick Menus.

Current Button

Pressing the CURRENT button the first time causes the menu system to jump directly to the current control menu of the Quick menus: without leaving the Standard menus system.

Pressing the CURRENT button while already in the current control menu causes the menu system to jump to the large format display.

Refer to the section, *Current Monitor Menu*, later in this chapter.

Shutter Button and Indicator

The SHUTTER button provides control over the shutter enable signal. This is not a direct control of the shutter output, only an enable. In order for the shutter to open, the shutter enable must be active *and* the eDrive must be in the active state. While in the standby or inactive states, the eDrive will not actuate the shutter. While in the active state, the shutter button will open and close the shutter. The state of the shutter enable signal is provided with the green shutter indicator above the button.

Emission Button and Indicator

The EMISSION button provides control over the state of the current output of the eDrive. The state of the output is provided with the white emission indicator above the button. Refer to the state table describing the function.

State	Functional Behavior / Notes	Current Output	Front Panel Emission Light	Laser On Light Signal	Shutter Enable Signal	Beeper
OFF	This is the safe state that the unit powers up into.	Off	Off	Off	Off	Off
PREFIRE	When the output is commanded on, the eDrive enters this state for five seconds to alert the users that the output is about to become active.	Off	Blinking	Blinking	Off	Beep-Beep
ACTIVE	This is the state that drives the laser to emit light.	Commanded current level	On	On	On	Off
STANDBY	This state can only be entered when it is enabled and commanded remotely. This state will deliver a standby current if so configured.	Standby	Blinking	Blinking	Off	Off
FAULT	This state is entered upon detection of a fault condition. The fault must be identified, removed, and cleared before normal operation may resume.	Off	Off	Off	Off	Off

Selection Knob

The selection knob provides the means for quickly selecting wide range values in the eDrive. Operation is straightforward. When the display indicates, use the selection knob to make adjustment to the parameter selected.

In some cases where it is impractical to make adjustments to the values with normal selection knob behavior, the display will indicate to press the selection knob to change the scale. Press and hold the selection knob for a brief period until the scale changes to 10x or 100x. This will facilitate quick excursions in the selected value. Press the selection knob again to return to 1x mode for fine adjustments. See the section *Quick Menus* below for more details on this control.

Keylock Switch

The keylock switch is intended to prevent the eDrive from being powered on. Turning the key to the OFF position will power the eDrive off. The key may be removed while in the OFF position only.

Emergency Stop Switch

The emergency stop switch is designed to be used in emergencies only. It is not intended to be used for stopping laser emission or powering off the eDrive.

When the Emergency Stop switch is pressed, the eDrive clamps the commanded current to zero and notifies the user on the front panel.

To return the switch to the safe state, rotate the red actuator button in the direction indicated by the arrows.

Standard Menus

This section outlines all of the displays used in the eDrive product line. Some of the eDrive menus depend on the related functionality being present. The menus for optional features will only be present if those options are present.

Banner

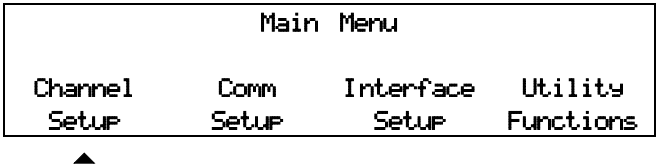
This display is presented at boot up time. The model name and firmware version will be displayed. Note that the actual firmware version number may differ for your system.

```
eDrive
Laser System Controller
Firmware Version 1.5.2
```

When your eDrive is first powered on, the next display will be the main menu. If you change to a different menu mode, that mode will be the first displayed after the banner.

Main

This is the main menu display. The eDrive displays this by default.



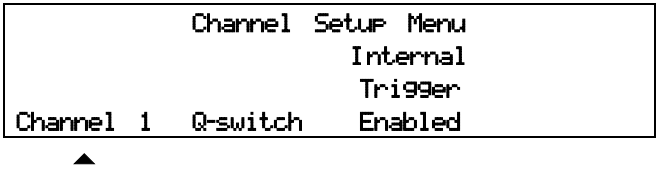
For a description of the communications setup menus, refer to the section *Communications Setup* later in this chapter.

For a description of the interface setup menus, refer to the section *Interface Setup* later in this chapter.

For a description of the utility functions setup menus, refer to the section *Utility Functions Setup* later in this chapter.

Channel Setup

This is the channel setup menu. For systems with more than one AIM channel, additional channel selections will be available (Channel 2, Channel 3).

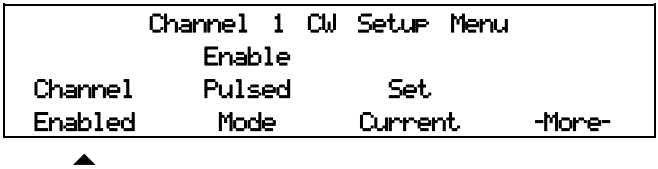


For a discussion of the triggering/gating functions, see *Triggering/Gating Setup* later in this chapter.

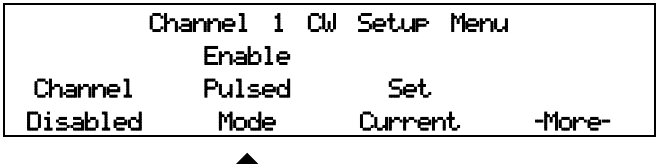
Channel CW Setup

This menu supports configuration of the channel 1 output (AIM).

Press Channel Enabled to toggle the channel enable.

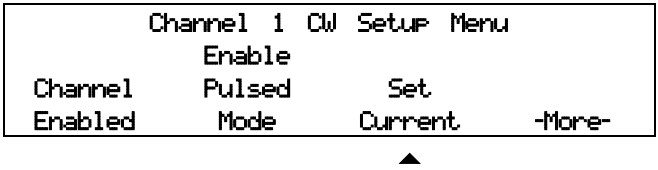


Press Enable Pulsed Mode to toggle between CW to QCW (pulsed) mode operation. This operation is only allowed when the channel is disabled and the drive is inactive.

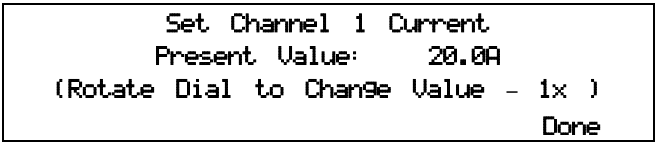


To proceed, you must acknowledge the prompt. Press NO to continue following along in this chapter. (See the Channel 1 Pulsed Setup Menu section for details.) Re-enable the channel.

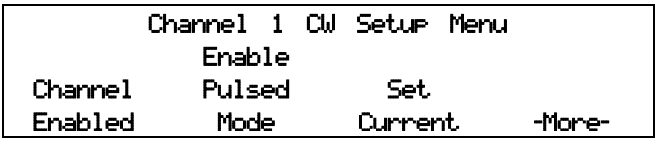
Press Set Current to set the current amplitude.



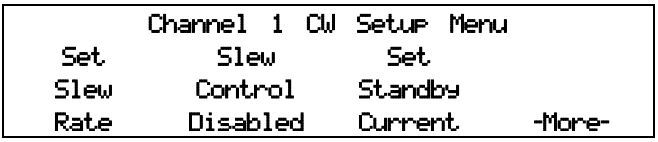
Use the selection knob to set the value. Press Done to enter the value.



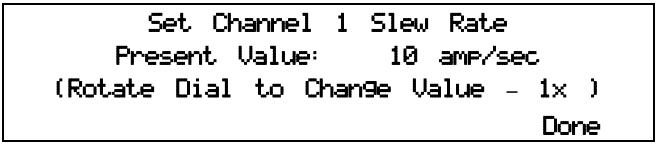
Press -More- to access additional options.



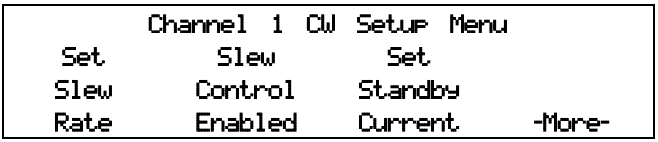
Press Set Slew Rate to set the rate of the current ramp.



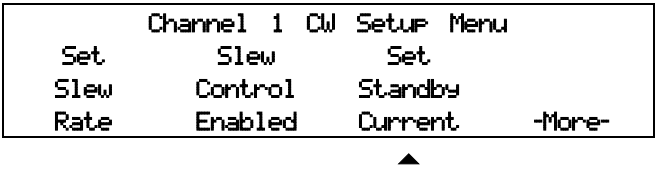
Use the selection knob to set the value. Press Done to enter the value.



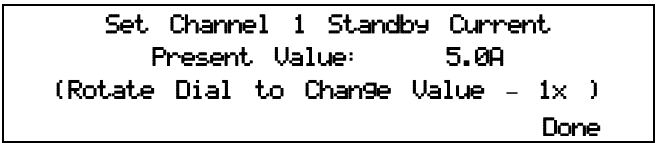
Press Slew Control Enabled to toggle between slew control enabled and disabled.



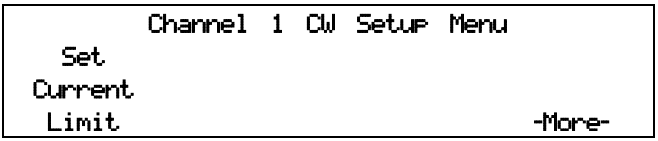
Press Set Standby Current to set the standby current.



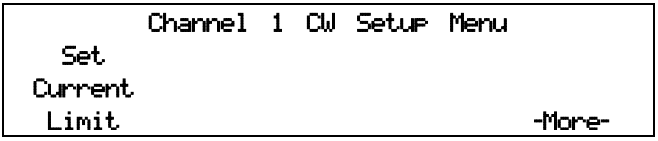
Use the selection knob to set the value. Press Done to enter the value.



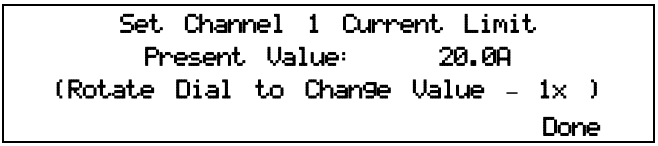
Press -More- to access additional options.



Press Set Current Limit to set the current limit value.



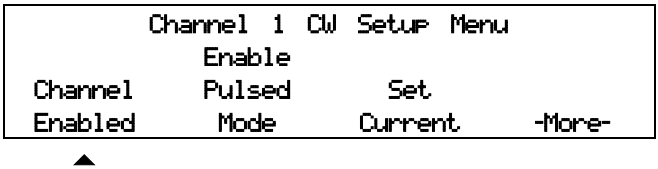
Use the selection knob to set the value. Press Done to enter the value.



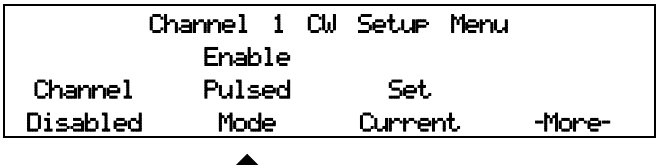
Channel Pulsed Setup

This menu supports configuration of the channel 1 output (AIM) in pulsed mode operation (equipped models only).

Press Channel Enabled to toggle the channel enable.

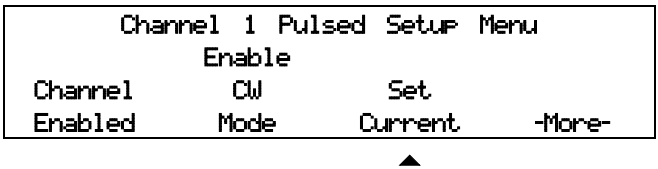


Press Enable Pulsed Mode to toggle from CW to QCW (pulsed) mode operation. This operation is only allowed when the channel is disabled.

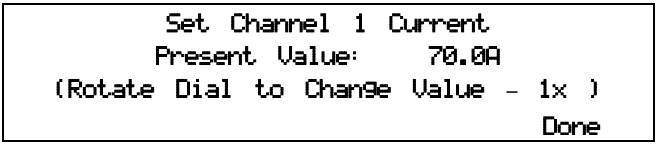


To proceed, you must acknowledge the prompt. Press YES. (See the Channel 1 CW Setup Menu section for details.) Re-enable the channel.

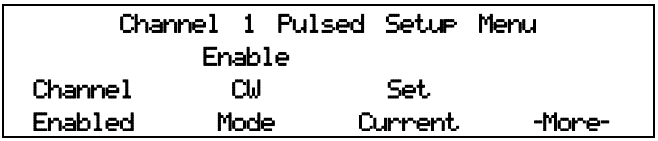
Press Set Current to set the channel current.



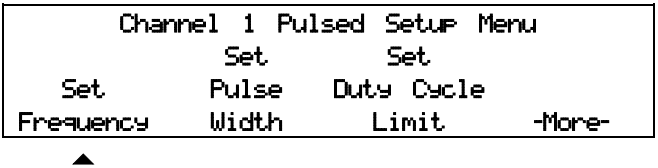
Use the selection knob to set the value. Press Done to enter the value.



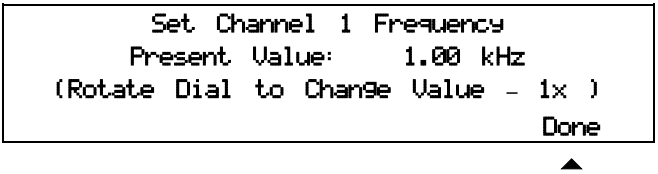
Press -More- to access additional options.



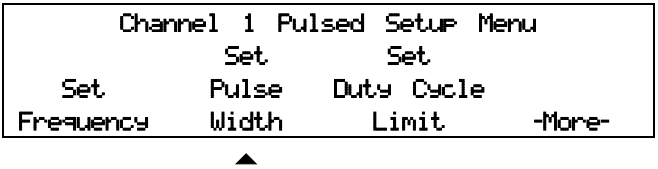
Press Set Frequency to set the pulse rate frequency (PRF) of the current pulse.



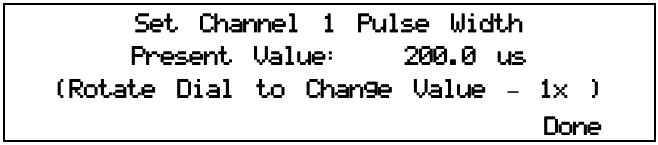
Use the selection knob to set the value. Press Done to enter the value.



Press Set Pulse Width to set the pulse width of the current pulse.

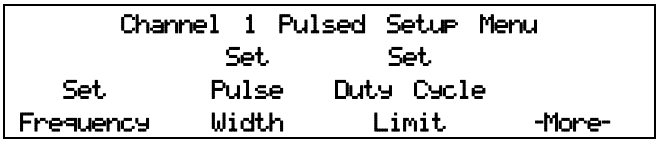


Use the selection knob to set the value. Press Done to enter the value.

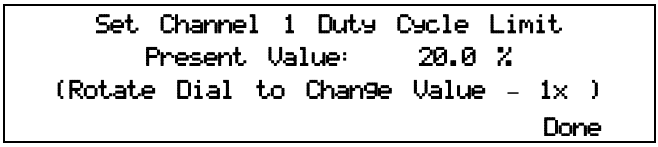


CEO recommends the use of a current probe and current monitor output to verify the output pulse width matches the commanded value. Some difference is normal depending on the load. The current monitor output (BNC) is located on the back panel. See section Getting Started, page 4. Use the PW offset menu option to match the actual PW to the commanded value, if desired. See menu options on page 89.

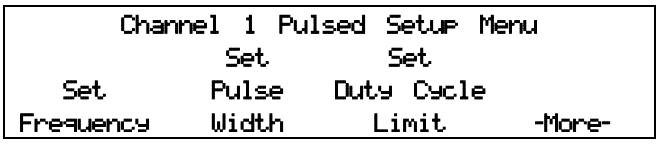
Press Set Duty Cycle Limit to set a limit on the duty cycle of the pulse rate frequency (PRF) of the current pulse. The duty cycle is the ratio of on-time to off-time of the pulse train.



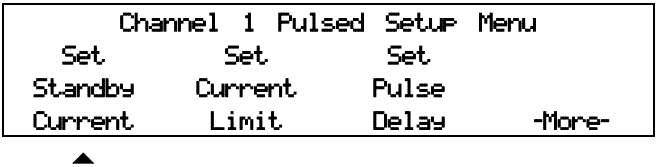
Use the selection knob to set the value. Press Done to enter the value.



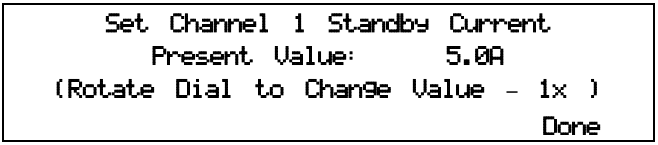
Press -More- to access additional options.



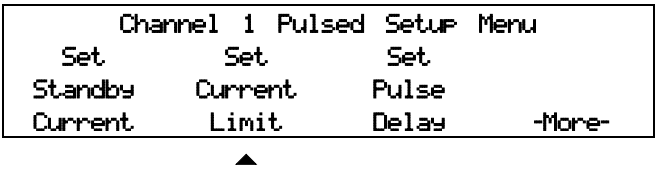
Press Set Standby Current to set the standby current.


Channel 1 Pulsed Setup Menu
Set Standby Current
Set Current Limit
Set Pulse Delay
-More-

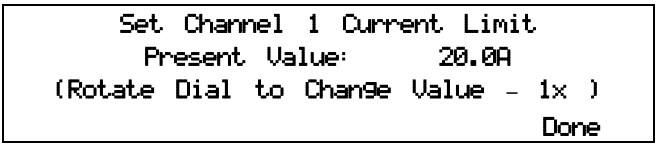
Use the selection knob to set the value. Press Done to enter the value.



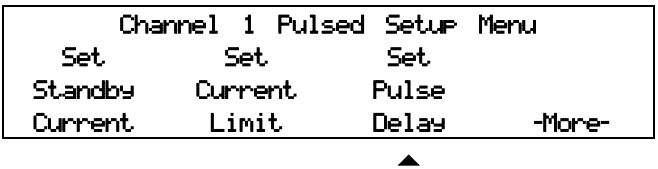
Press Set Current Limit to set the current limit value.



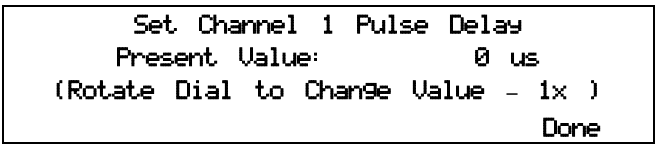
Use the selection knob to set the value. Press Done to enter the value.



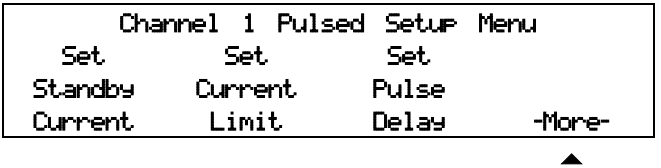
Press Set Pulse Delay to set the delay from the trigger to the pulse.



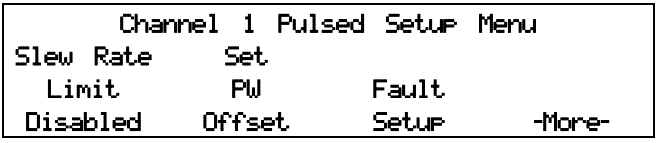
Use the selection knob to set the value. Press Done to enter the value.



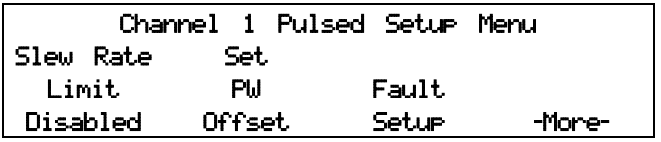
Press -More- to access additional options.



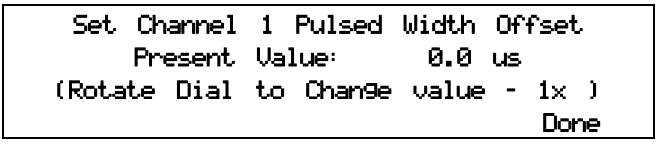
Press Slew Rate Limit Disabled/Enabled to toggle the slew rate limit function. Refer to the chapter *Operating Basics* for a description of this function.



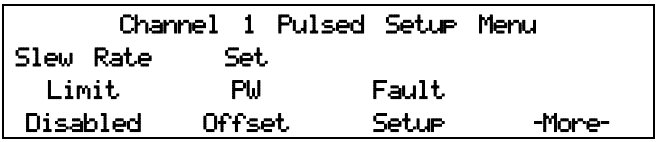
Press Set PW Offset to set the pulse width offset.



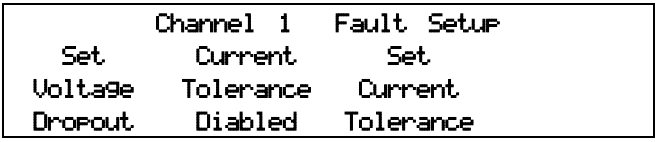
Use the selection knob to set the value. Press done to enter the value.



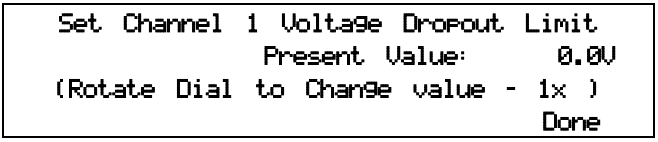
Press Fault Setup to set the pulse width offset.



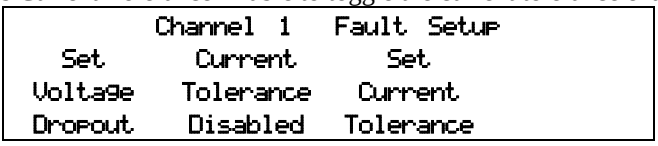
Press Fault Setup to set the pulse width offset.



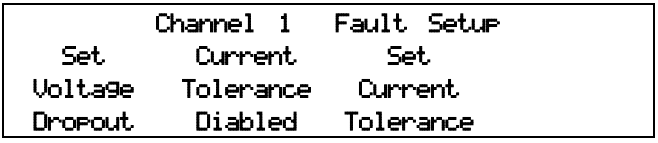
Use selection knob to set value. Press Done to enter value.



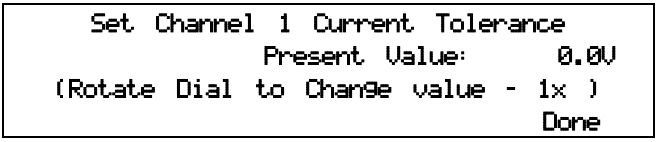
Press Current Tolerance Enable to toggle the current tolerance enable.



Press Set Current Tolerance to set the current tolerance.



Use selection knob to set value. Press Done to enter value.



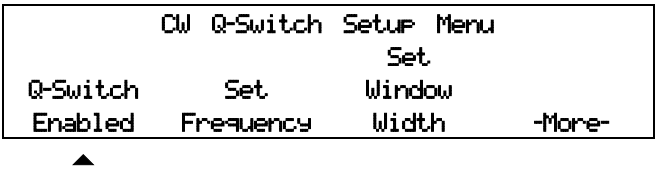
CW Q-Switch Setup Menu (eDrive)

This menu supports configuration of the Q-switch operation.

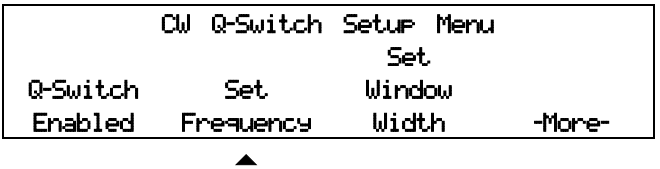
NOTE. The Q-switch menu will display either CW or Pulsed mode depending on the mode selected for Channel 1.

This is the channel setup menu. Press Q-Switch to select Q-Switch setup menus.

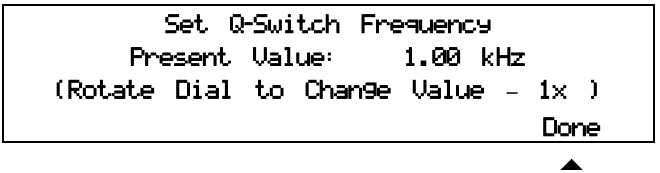
Press Q-switch Enabled to toggle the Q-switch enable. Make sure that it is enabled.



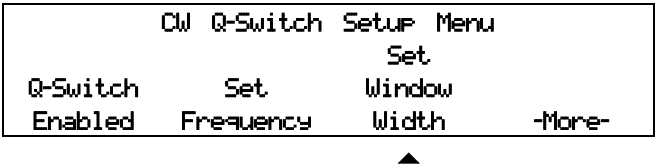
Press Set Frequency to set the Q-switch repetition frequency.



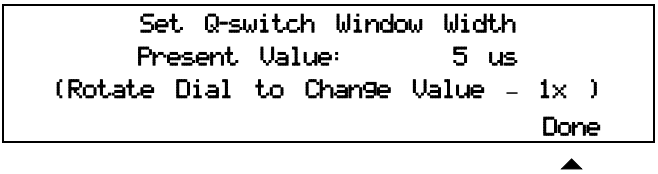
Use the selection knob to set the value. Press Done to enter the value.



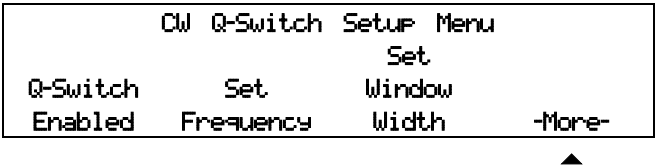
Press Set Window Width to set the width of the Q-switch window.



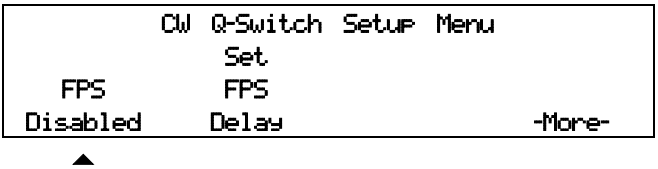
Use the selection knob to set the value. Press Done to enter the value.



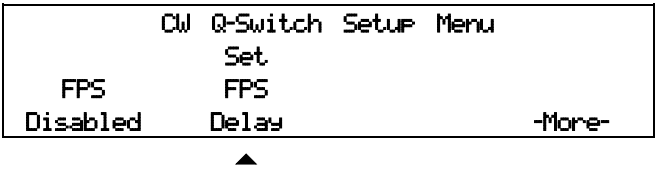
Press -More- access more options.



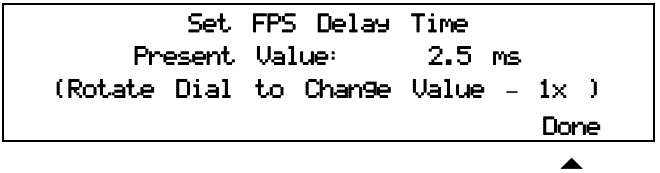
Press FPS Disabled to toggle the state of the first pulse suppression function. Set it to meet your laser system requirements.



Press Set FPS Delay to set the time limit required to activate a first pulse suppression.



Use the selection knob to set the value. Press Done to enter the value.



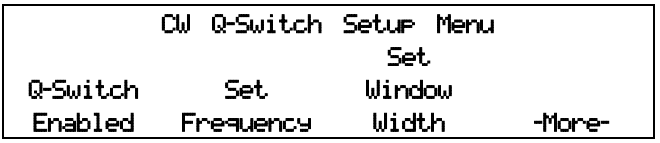
CW Q-Switch Setup Menu (eDrive Nitro and Aero)

This menu supports configuration of the Q-switch operation.

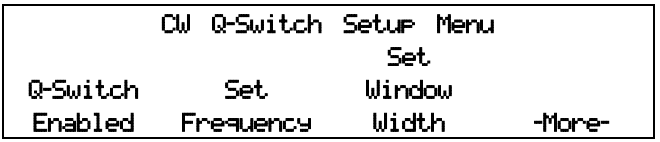
NOTE. The Q-switch menu will display either CW or Pulsed mode depending on the mode selected for Channel 1.

This is the channel setup menu. Press Q-Switch to select Q-Switch setup menus.

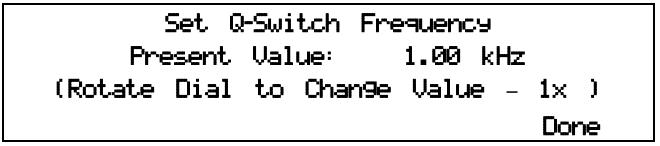
Press Q-switch Enabled to toggle the Q-switch enable. Make sure that it is enabled.



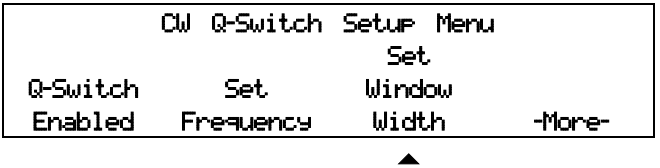
Press Set Frequency to set the Q-switch repetition frequency.



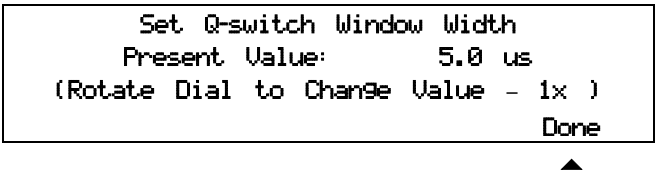
Use the selection knob to set the value. Press Done to enter the value.



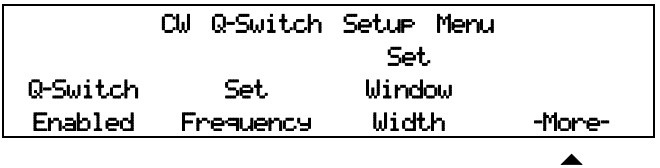
Press Set Window Width to set the width of the Q-switch window.



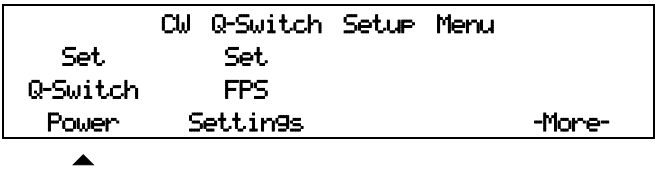
Use the selection knob to set the value. Press Done to enter the value.



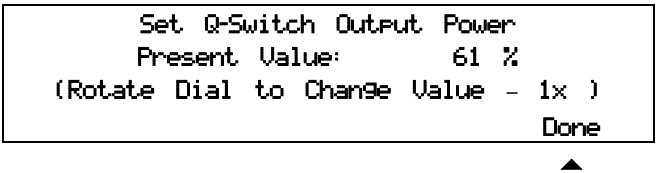
Press -More- to access additional options.



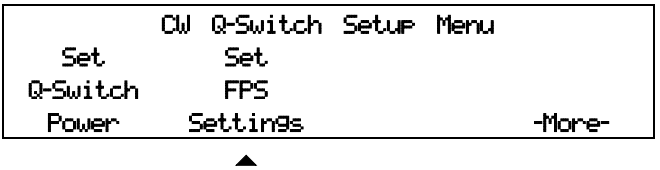
Press Set Q-Switch Power to access the Q-switch power modulation feature. Refer to the chapter *Operating Basics* for a description of this feature.



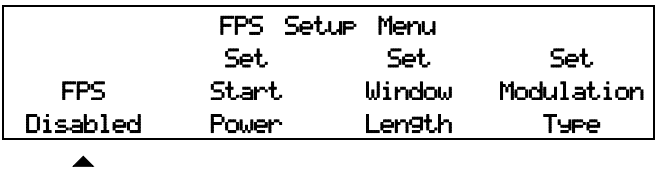
Use the selection knob to set the value. Press Done to enter the value.



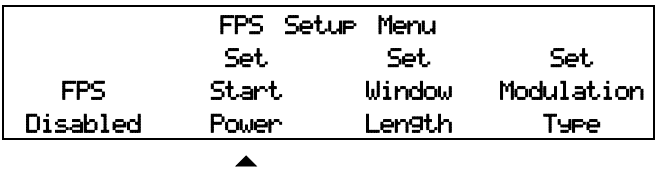
Press Set FPS Settings to access the Q-switch first pulse suppression feature. Refer to the chapter *Operating Basics* for a description of these features.



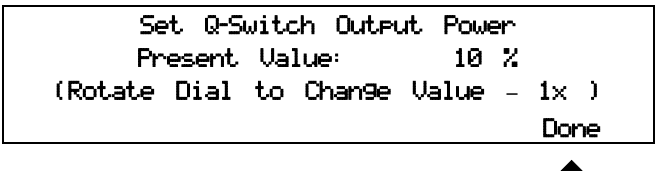
Press FPS Disabled/Enabled to toggle the state of the FPS function.



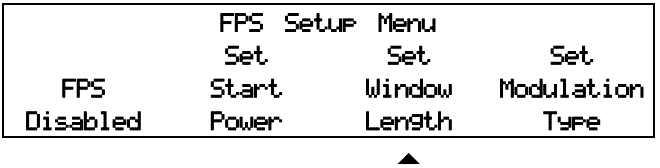
Press Set Start Power to adjust the starting power of the Q-switch driver output during first pulse suppression.



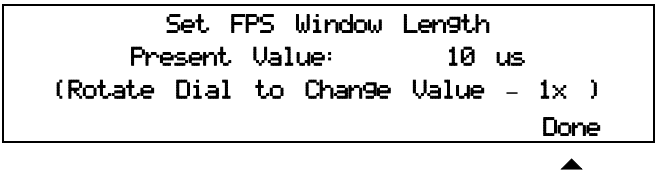
Use the selection knob to set the value. Press Done to enter the value.



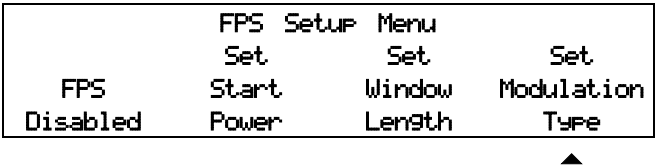
Press Set Window Length to adjust the duration of the Q-switch first pulse suppression window.



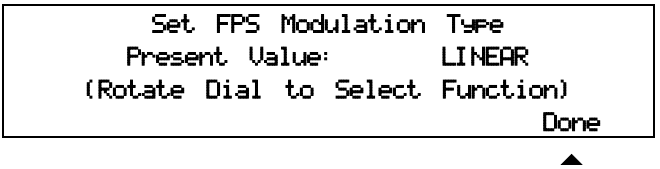
Use the selection knob to set the value. Press Done to enter the value.



Press Set Modulation Type to adjust the type of modulation used in the Q-switch first pulse suppression window.



Use the selection knob to set the value. Select from [LINEAR, EXPONENTIAL, SINE, SINE^2]. Press Done to enter the value.



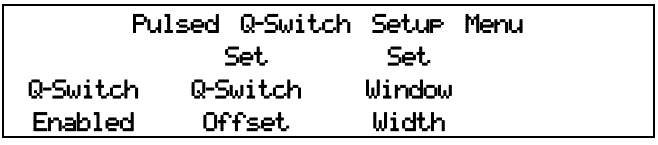
Pulsed Q-switch Setup Menu (eDrive)

This menu supports configuration of the Q-switch operation in QCW (pulsed) mode.

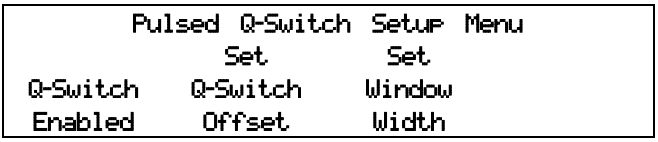
NOTE. The Q-switch menu will display either CW or Pulsed mode depending on the mode selected for Channel 1.

This is the channel setup menu. Press Q-Switch to select Q-Switch setup menus.

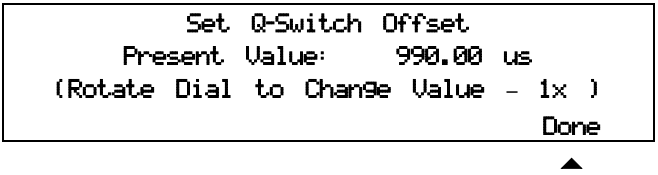
Press Q-Switch Enabled to toggle the Q-switch enable. Make sure that it is enabled.



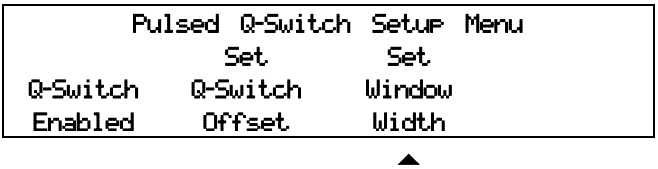
Press Set Q-Switch Offset to set the Q-switch offset relative to the end of the current pulse.



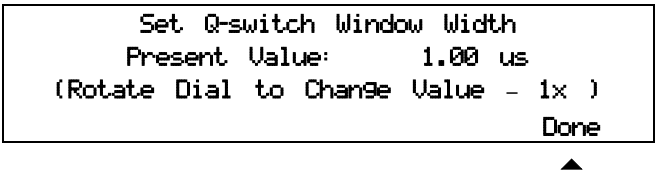
Use the selection knob to set the value. Press Done to enter the value.



Press Set Window Width to set the width of the Q-switch window.



Use the selection knob to set the value. Press Done to enter the value.



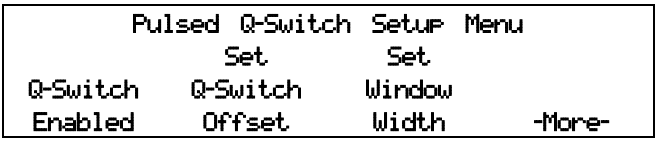
Pulsed Q-switch Setup Menu (eDrive Nitro and Aero)

This menu supports configuration of the Q-switch operation in QCW (pulsed) mode

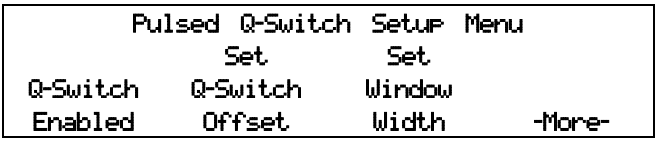
NOTE. The Q-switch menu will display either CW or Pulsed mode depending on the mode selected for Channel 1.

This is the channel setup menu. Press Q-Switch to select Q-Switch setup menus.

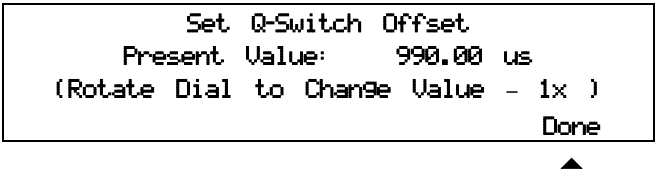
Press Q-Switch Enabled to toggle the Q-switch enable. Make sure that it is enabled.



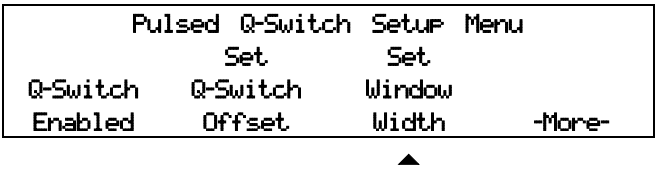
Press Set Q-Switch Offset to set the Q-switch offset relative to the end of the current pulse.



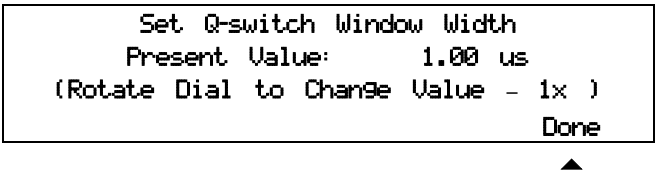
Use the selection knob to set the value. Press Done to enter the value.



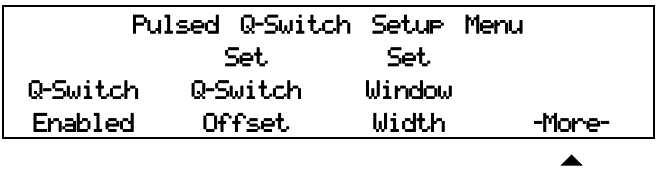
Press Set Window Width to set the width of the Q-switch window.



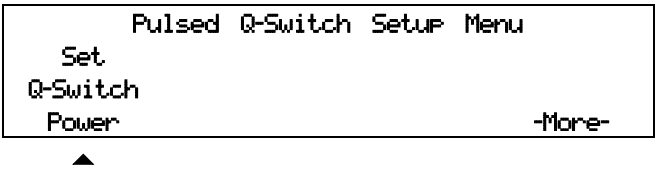
Use the selection knob to set the value. Press Done to enter the value.



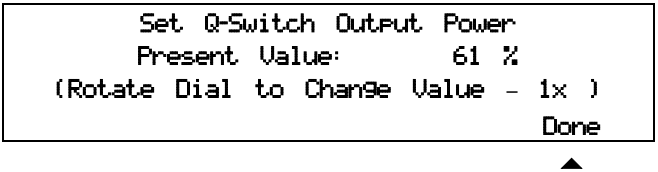
Press -More- to access additional options.



Press Set Q-Switch Power to access the Q-switch power modulation feature. Refer to the chapter *Operating Basics* for a description of this feature.



Use the selection knob to set the value. Press Done to enter the value.



Triggering/Gating

Refer to *Understanding Driver Functions* for an explanation of the various triggering and gating modes.

This is the channel setup menu. Press button 3 to select the various triggering/gating options. When the display is as shown below, all trigger events are generated internally using the Timing Engine™.

```
             Channel  Setup  Menu
                        Internal
                         Trigger
Channel  1   Q-switch    Enabled
```

When the display is as shown below, all trigger events are generated externally using a signal input on the trigger/gate input connector.

```
             Channel  Setup  Menu
                        External
                         Trigger
Channel  1   Q-switch    Enabled
```

When the display is as shown below, all trigger events are generated internally using the Timing Engine™ and may be interrupted using a signal input on the trigger/gate input connector.

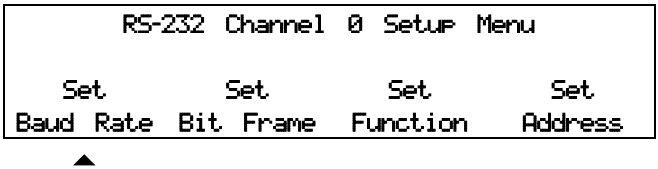
```
             Channel  Setup  Menu
                        External
                          Gate
Channel  1   Q-switch    Enabled
```

Communications Setup

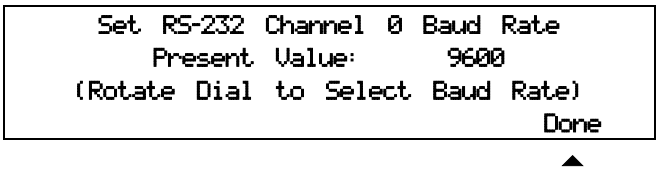
This is the main menu display. Press Comm Setup to select the communications setup menus.

This is the Communications Setup Menu. It is used to configure the various serial interfaces in the eDrive. Press RS-232 Channel 0 Setup to configure the serial port for your application. Note that RS-232 Channel 1 and RS-485 setup are essentially identical and will not be described separately.

Press Set Baud Rate.

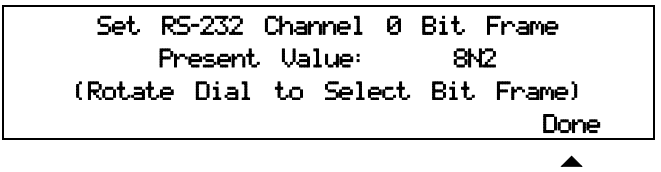


Use the selection knob to set the value. Select from [1200, 2400, 4800, 9600, 19200, 38400]. Press Done to enter the value.



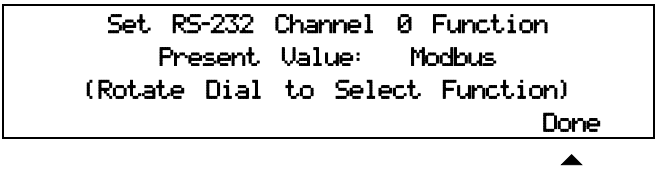
Press Set Bit Frame.

Use the selection knob to set the value. Select from [8N1, 8O1, 8E1, 8N2]. Refer to the chapter *Communications* for details on bit frame. Press Done to enter the value.



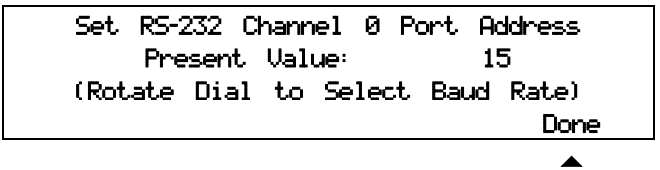
Press Set Function.

Use the selection knob to set the value. Select from [None, Modbus, Loopback]. Press Done to enter the value.

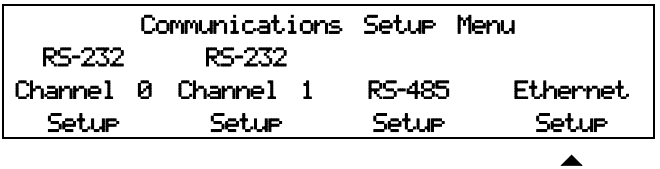


Press Set Address.

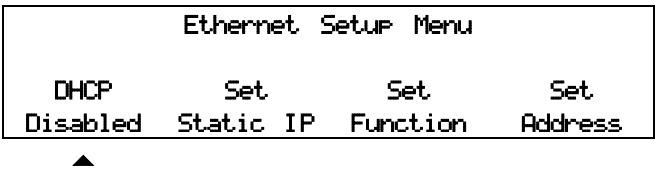
Use the selection knob to set the value. Refer to the chapter *Communications* for details on port address. Press Done to enter the value.



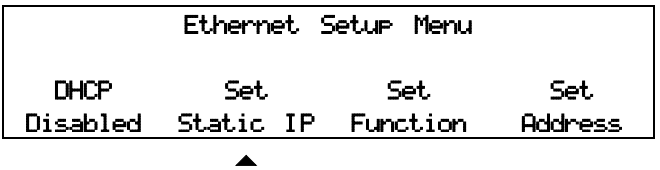
Press Ethernet Setup to configure the Ethernet interface parameters. Ask your network system administrator if you need help selecting these parameter values.



Press DHCP Disabled to toggle DHCP to the enabled state. When DHCP is enabled, the eDrive will obtain its Ethernet parameters from a DHCP server on the network.

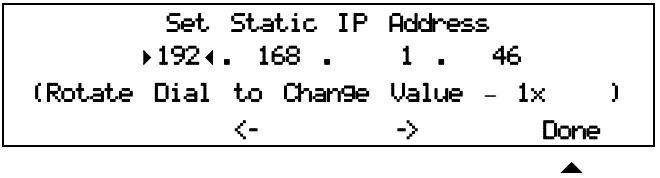


Press Set Static IP to set the static IP parameters.

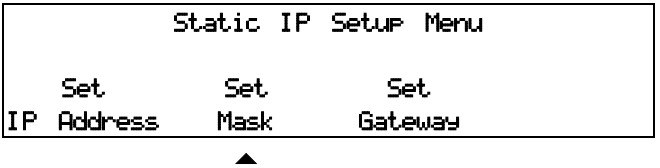


Press Set IP Address to set the IP address.

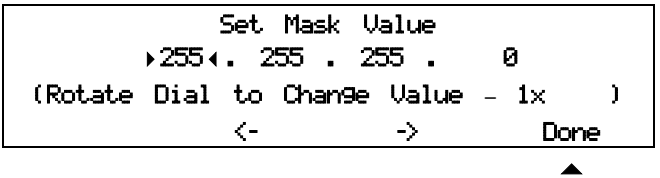
Use the selection knob to set each value. Press ← or → to switch between parameters. Press Done to enter the values.



Press Set Mask to set the IP address mask.

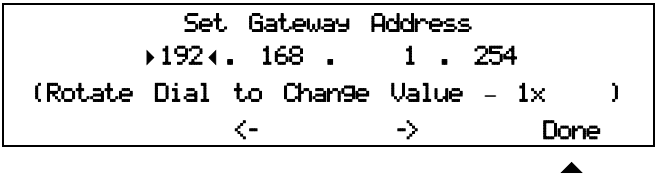


Use the selection knob to set each value. Press ← or → to switch between parameters. Press Done to enter the values.



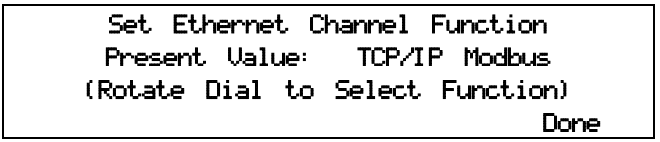
Press Set Gateway to set the gateway IP address.

Use the selection knob to set each value. Press ← or → to switch between parameters. Press Done to enter the values.



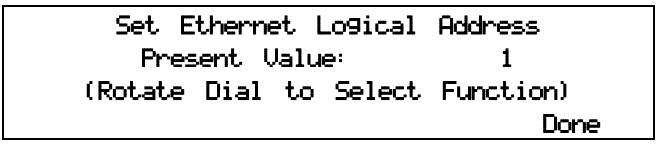
Press Set Function to set the function of the Ethernet interface.

Use the selection knob to set the value. Select from [None, Modbus]. Press Done to enter the value.



Press Set Address to set the Modbus address of the Ethernet interface.

Use the selection knob to set the value. Press Done to enter the value.

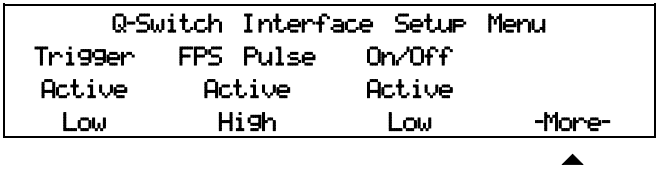


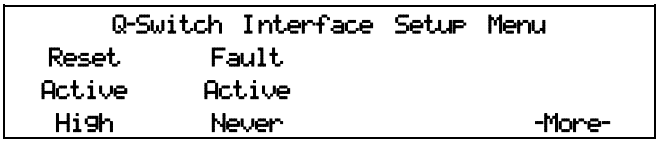
Interface Setup

This is the main menu display. Press Interface Setup to select the interface setup menus. Some eDrive-series products will have no additional interfaces to set up and this menu option will not work in those cases.

This is the Interface Setup Menu. It is used to configure the various miscellaneous interfaces in the eDrive other than serial ports. Press Q-Switch Setup (eDrive only).

Set the logical sense of the various Q-Switch interface signals using the signal options to match your Q-switch controller. Press -More- for additional options.

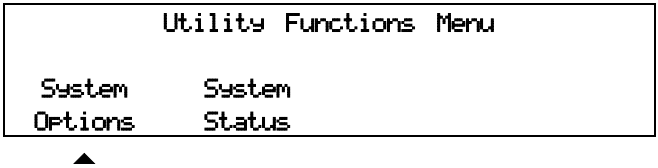




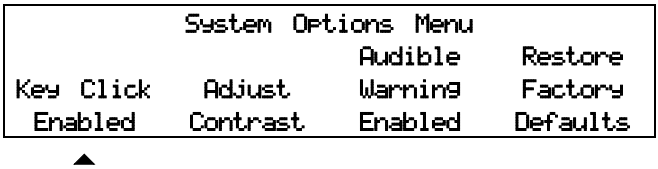
Utility Functions

This is the main menu display. Press Utility Functions to select the utility functions menus.

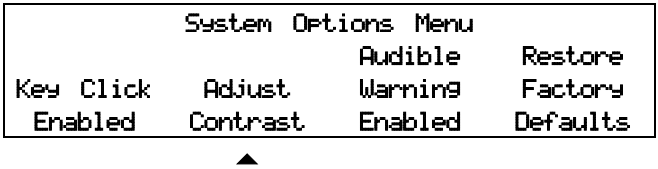
This is the Utility Functions Menu. It is used to set and read the various miscellaneous system-level parameters in the eDrive. Press System Options.



Select whether the eDrive should produce an audible click when keys are pressed.

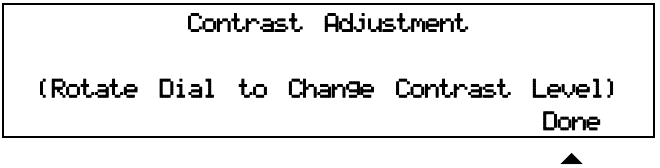


It may be necessary to adjust the LCD contrast if your viewing angle is different than the typical viewing angle. Press Adjust Contrast.

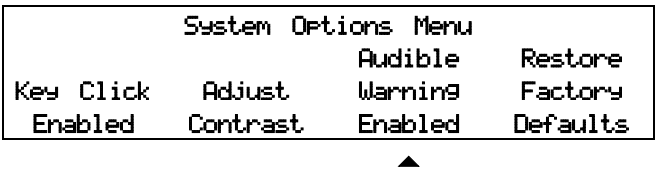


When in contrast adjustment mode, use the rotary encoder to change the contrast and press any key to exit. Note that the system may

prompt you to exit standby or active mode in order to enter contrast adjust mode. Press Done when adjustment is complete.

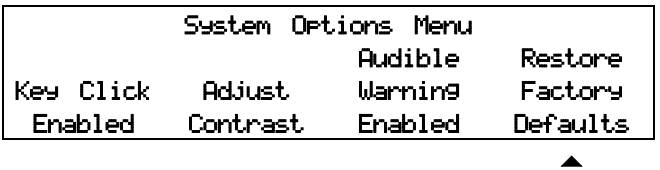


Select whether the eDrive should produce a periodic audible beep when current is flowing to the laser as a safety reminder.

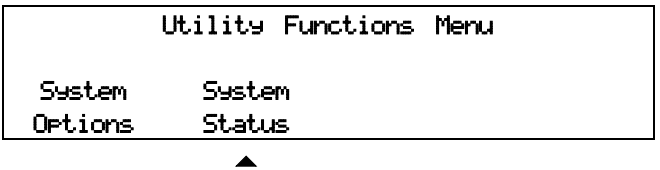


Select Restore Factory Defaults to return your eDrive to its factory configuration.

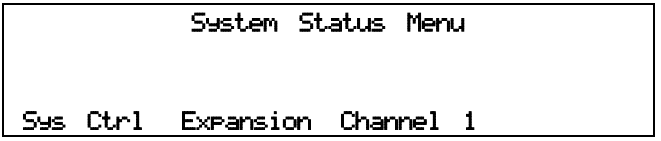
NOTE. Selecting this option will cause the eDrive to lose all of the setup parameters previously set. Be sure to record your configuration before restoring factory defaults.



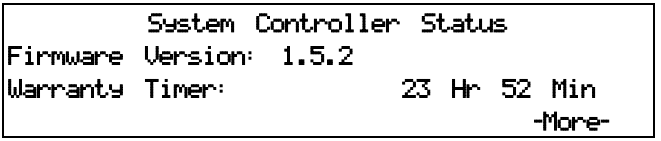
Return to the Utility Functions Menu and press System Status.

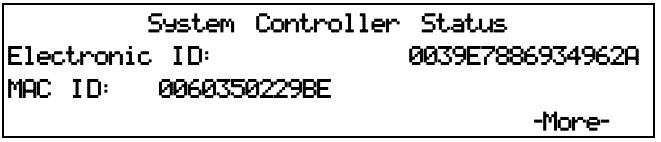


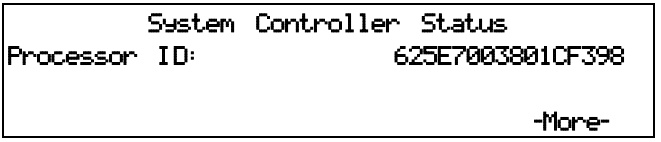
Press Sys Ctrl. Note: Only eDrive Nitro drivers have expansion modules.

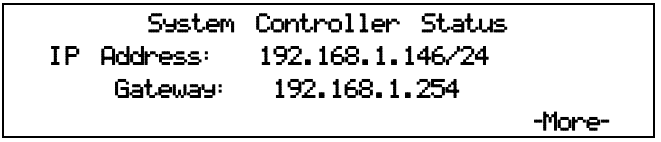


The eDrive will present consecutive screens of system information. Press -More- repeatedly.





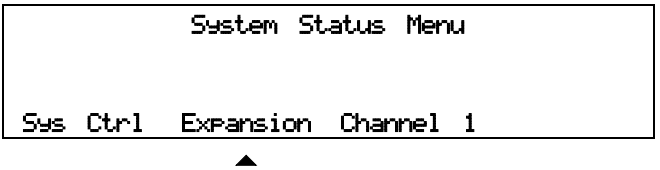




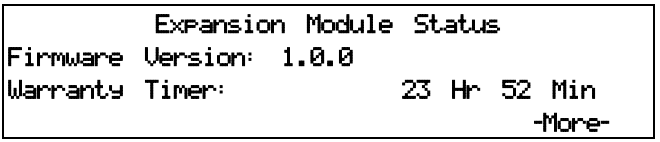
System Controller Status
Front Panel Firmware Ver.: 6
Front Panel ID: 00000C3CFFF001
-More-

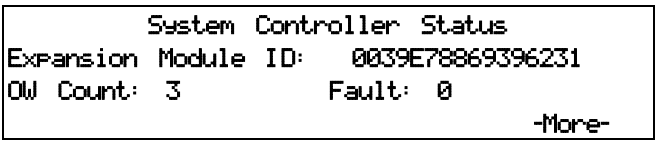
Press MENU to return to System Status Menu.

Press Expansion. Note: Only eDrive Nitro drivers have expansion modules.



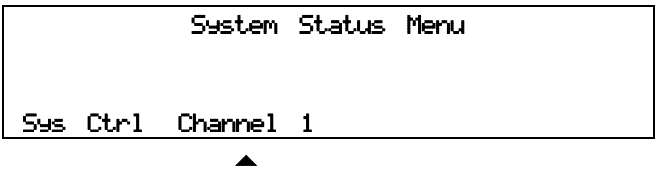
The eDrive will present consecutive screens of system information. Press -More- repeatedly.



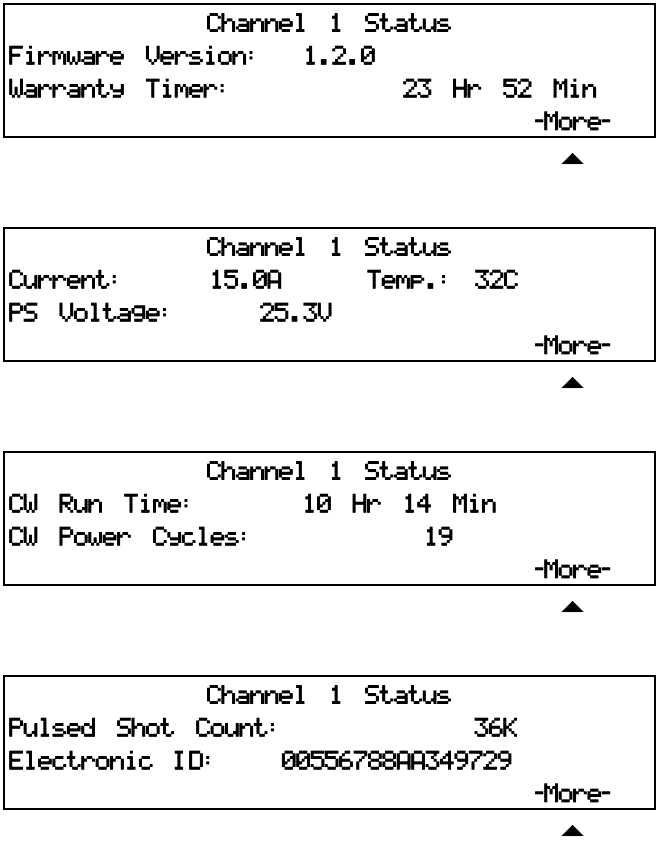


Press MENU to return to System Status Menu.

Press Channel 1.



The eDrive will present consecutive screens of channel 1 information. Press -More- repeatedly.



Quick Menus

The eDrive has a feature called Quick Menus that allow most of the functions to be disabled but provides access to the key features of the eDrive. To switch Quick Menus on and off, press and hold MENU for three seconds until the display changes.

In Quick Menus, the configuration of the eDrive is not available. If the eDrive was configured for CW operation, then the CW Quick Menus will be displayed. If the eDrive was configured for QCW, or pulsed, operation, then the pulsed Quick Menus will be displayed.

In Quick Menus, the ▸ ◂ symbols indicate the parameter that will be modified with the selection knob. To switch between fine and course adjustment of the selected parameter, press and hold the selection knob until the selection symbols change. Fine adjustment is indicated by ▸ ◂ , coarse adjustment is indicated by ▸▸ ◂◂. (Some parameters may have three levels.)

CW Quick Menus

This is display 1 of the CW-mode Quick Menus. Use the selection knob to adjust the current amplitude.

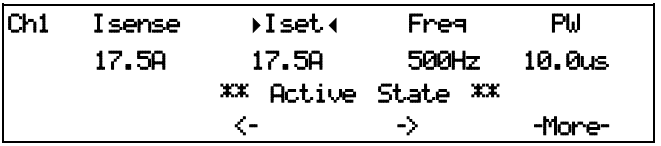
Press the selection knob to change adjustment sensitivity. Press -More- to switch to CW-mode display 2.

This is display 2 of the CW-mode Quick Menus. Note that there are no settable parameters on this display. Press -More- to switch to CW-mode display 3.

This is display 3 of the CW-mode Quick Menus. This display may not be present if the Q-switch has been disabled. Press ← or → to switch between parameters. Press -More- to switch to return to display 1.

Pulse-mode Quick Menus

This is display 1 of the pulse-mode Quick Menus. Use the selection knob to adjust the current amplitude.

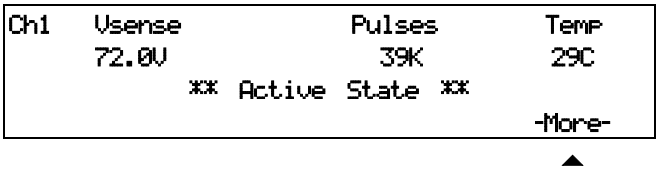


Press the selection knob to change adjustment sensitivity.

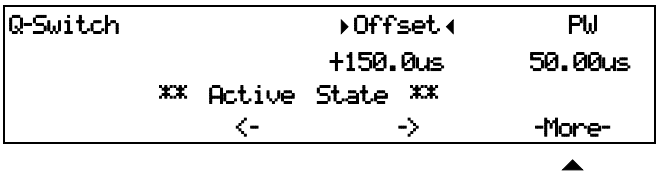
Press ← or → to switch between parameters.

Press -More- to switch to pulse-mode display 2.

This is display 2 of the pulse-mode Quick Menus. Note that there are no settable parameters on this display. Press -More- to switch to pulse-mode display 3.



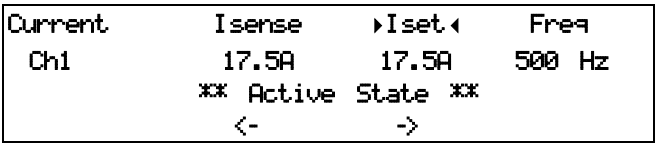
This is display 3 of the pulse-mode Quick Menus. This display may not be present if the Q-switch has been disabled. Press -More- to switch to return to display 1.



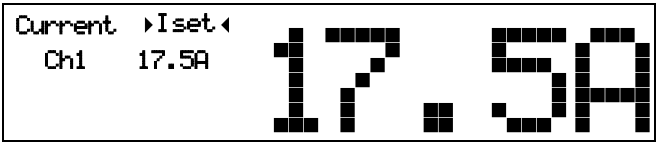
Current Monitor Menu

This convenient menu brings the quick access feature of the Quick Menus to the Standard Menus system. This mode is accessed by pressing CURRENT and is only accessible while in Standard Menus mode.

Refer to the Quick Menus section for operation of these menus.



Press MENU to return to the standard menus or press CURRENT again to enter the large current display. This mode assists in viewing the driver current from a distance.



Error Displays

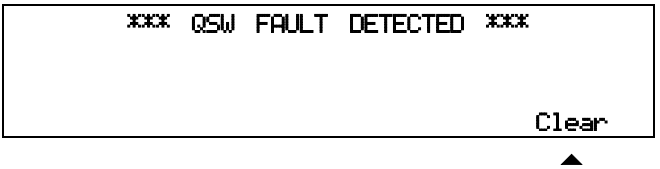
The eDrive will display error messages when a fault occurs. This section outlines those displays.

This display appears when the emergency stop switch or user interlock is activated. Correct the fault and then press Clear.

This display appears when the chiller interface connector coolant flow interlock faults. Correct the fault and then press Clear.

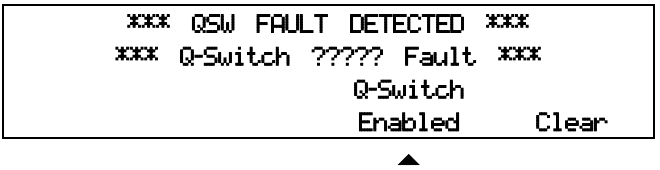
This display appears when the chiller interface connector coolant level interlock faults. Correct the fault and then press Clear.

This display appears when the Q-switch interface connector fault signal is asserted (eDrive only). The state of the signal that triggers the fault is set by the menus. Correct the fault and then press Clear. If you cannot clear the fault at the connector interface, power the eDrive off and then on to restore normal operation.

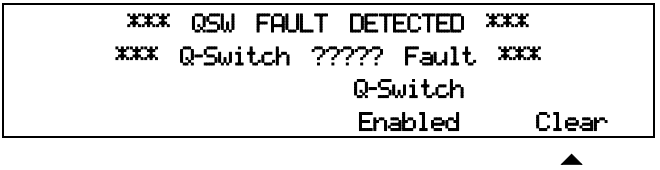


This display appears when one of the internal Q-switch fault signals is asserted (eDrive Nitro/Aero only). Correct the fault and then press Clear. If you cannot clear the fault at the connector interface, power the eDrive off and then on to restore normal operation. Note that the internal Q-switch driver has multiple fault modes. The specific fault will be identified in the fault window below where the ????? is shown. Refer to the chapter *Operating Basics* for details on this feature.

Press Q-Switch Enabled to toggle the state of the RF driver to disabled if you wish to continue using the driver without correcting the fault.



Press Clear to clear the fault display after correcting the fault.



Appendix A: Specifications

Operational Specifications

	Air Cooled 300A		Water Cooled 300A	
	CW	QCW	CW	QCW
Amplitude:				
Output Current	50A	≤100.0% D.C. @50A	70A	≤100.0% D.C. @70A
	-----	≤15.0% D.C. @ 140A	-----	≤50.0% @100A
	-----	≤12.5% D.C. @160A	-----	≤15.0% D.C. @200A
	-----	≤10.0% D.C. @190A	-----	≤7.0% @300A
	-----	≤7.5% D.C. @240A	-----	-----
	-----	≤5.0% D.C. @270A	-----	-----
	-----	≤4.0% D.C. @300A	-----	-----
Display Resolution	100mA	100mA	100mA	100mA
Accuracy	2%	2%	2%	2%
Noise	< 200mA$_{peak}$	< 200mA$_{peak}$	< 200mA$_{peak}$	< 200mA$_{peak}$
	Air Cooled 100A		Water Cooled 100A	
	CW	QCW	CW	QCW
Amplitude:				
Output Current	50A	≤30.0% D.C. @100A	70A	≤70.0% D.C. @100A
Display Resolution	100mA	100mA	100mA	100mA
Accuracy	2%	2%	2%	2%
Noise	< 200mA$_{peak}$	< 200mA$_{peak}$	< 200mA$_{peak}$	< 200mA$_{peak}$
Pulse Rate:				
Range	-----	2 Hz – 50 kHz	-----	2 Hz – 50 kHz
Display Resolution				
(1 Hz)	-----	0 – 100 Hz	-----	0 – 100 Hz
(10 Hz)	-----	100 – 1 kHz	-----	100 – 1 kHz
(100 Hz)	-----	1 – 50 kHz	-----	1 – 50 kHz

Accuracy	-----	± 2%	-----	± 2%
Pulse Width:				
Range	-----	10 μs – 500 ms	-----	10 μs – 500 ms
Display Resolution	-----	100 ns	-----	100 ns
Transition Time	-----	5 μs (typ)	-----	5 μs (typ)
Trigger In:				
Type	-----	Positive edge triggered	-----	Positive edge triggered
Signal input	-----	TTL or 5V CMOS	-----	TTL or 5V CMOS
Minimum Width	-----	50 μs	-----	50 μs
Input Impedance	-----	50 Ω	-----	50 Ω
Compliance[1]:				
Voltage Compliance[2]	0 – 350V	0 – 350V	0 – 350V	0 – 350V
Display Resolution	0.1 V	0.1 V	0.1 V	0.1 V
Accuracy	± 2%	± 2%	± 2%	± 2%

Miscellaneous Specifications

	Air Cooled		Water Cooled	
	CW	QCW	CW	QCW
Operating Temperature:	0 – 40 °C	0 – 40 °C	0 – 40 °C	0 – 40 °C
Operating Humidity:	0-80% Non-Condensing	0-80% Non-Condensing	0-80% Non-Condensing	0-80% Non-Condensing
Pulse Width:				
Range	-----	10 μs – 500 ms	-----	10 μs – 500 ms
Display Resolution	-----	100 ns	-----	100 ns
Transition Time	-----	5 μs (typ)	-----	5 μs (typ)
Current Monitor:	100A			
Output Voltage (10A/V)	0 – 10 V	0 – 10 V	0 – 10 V	0 – 10 V
Accuracy	± 2%	± 2%	± 2%	± 2%
Current Monitor:	300A			
Output Voltage (20A/V)	0 – 15 V	0 – 15 V	0 – 15 V	0 – 15 V
Accuracy	± 2%	± 2%	± 2%	± 2%
Water Cooling:				
Pressure Drop	-----	-----	0.5 PSI	0.5 PSI
Maximum Pressure	-----	-----	60 PSI	60 PSI

Minimum Coolant Flow Rate	-----	-----	1 GPM	1 GPM

[1] Compliance voltage is defined as the maximum voltage a current source will go to in order to source the programmed current. In the case of the eDrive, the compliance voltage is the maximum voltage which can be applied to the diode array in order to achieve the desired current flow.

[2] The eDrive has been tested to comply with the requirements for CE marking for compliance voltages up to 60 Volts. For compliance voltages in excess of 60 Volts, contact the factory for more information.

NOTE: User must minimize overload voltage. Refer to section on Operating Basics pages 23-41.

Electrical Specifications

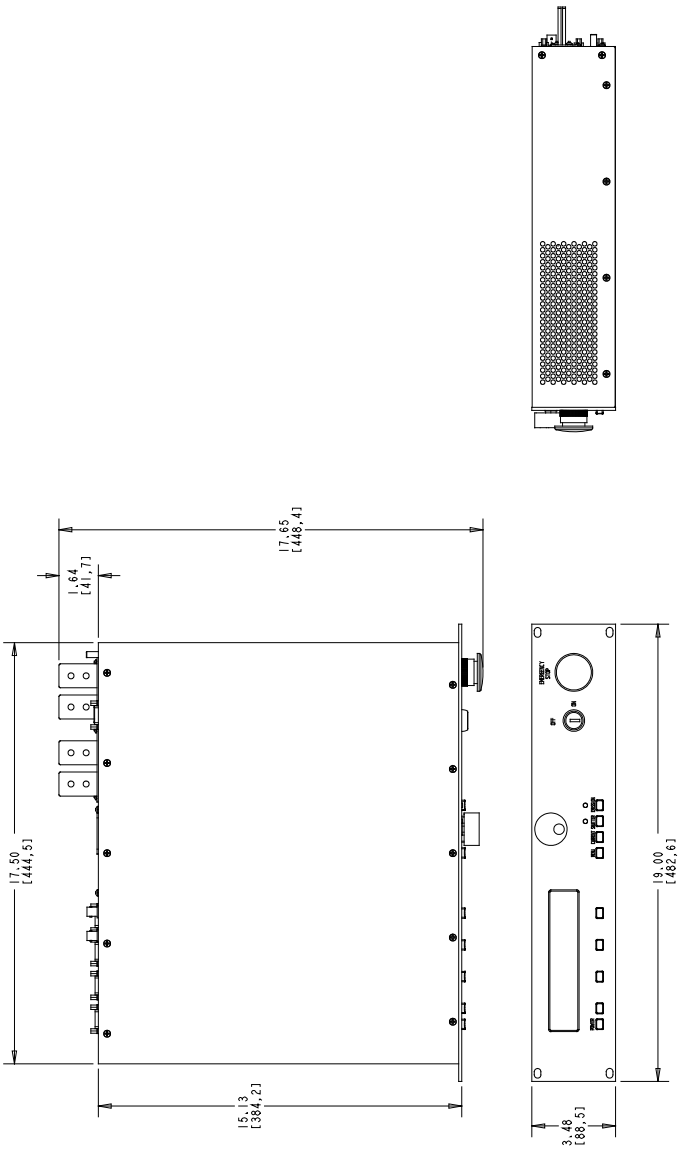
Input Power Specifications: eDrive (Base)

AC Input		Frequency
100-240 VAC	4A max.	50/60 Hz

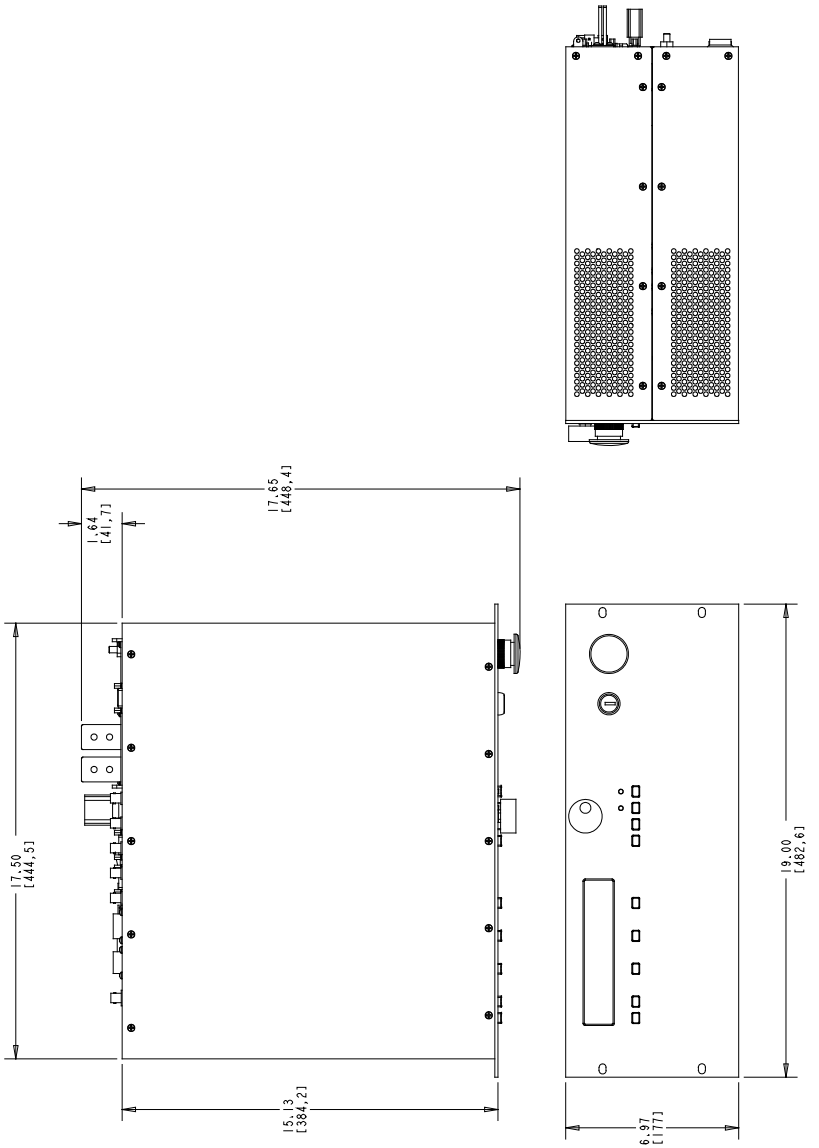
Input Power Specifications: eDrive Nitro, Aero

AC Input		Frequency	Fuse Ratings (F1, F2)
120V ±10%	15A	50/60 Hz	T 15A 250V
240V ±10%	8A	50/60 Hz	T 8A 250V
			Fuse Dimensions: 0.25 x 1.25 inches

eDrive Mechanical Outline



eDrive Nitro and Aero Mechanical Outline



Model Numbers

eDrive Base Model Number

Build an eDrive model number using the following guide. Note that this guideline may become outdated as new features are added.

Model[1..2]. These characters of the model number are always “ED” (indicates that this is an eDrive.)

Model[3]. This character indicates the chassis size.
2: 2U
4: 4U

Model[4]. This character indicates the operational modes of the driver.
C: CW operation only
P: CW or QCW (pulsed) operation
L: fiber laser product (see Aero part number extension)

Model[5..7]. These characters are always “-AX” for the standard product.

Model[8]. This character indicates the cooling method used.
A: air-cooled
W: water-cooled

If the driver is an eDrive (2U), the model number ends at this point.

eDrive Nitro Model Number

If the driver is an eDrive Nitro, continue the base model number above with these characters.

Model[9]. This character is always a “-”.

Model[10..12]. These characters indicate the rated voltage of the internal power supply (in volts). The range of this field will typically be 3 to 25 volts over the expected output voltage depending on delivered current. If the value is less than 100, only two digits will be utilized.

Model[13..14]. These characters indicate the maximum rated current of the internal power supply (in amps). The range of this field will typically be 20 to 100 amps.

Model[15]. This character indicates the number of Q-switch RF outputs provided.
N: a single-output RF output is provided (27MHz, 50W)
D: a dual-output RF output is provided (27MHz, 100W)
X: no RF driver is utilized

Model[16]. This character is always a "-".

Model[17..20]. These characters are for factory use only.

The model number ends at this point.

eDrive Aero Model Number

If the driver is an eDrive Aero, continue the base model number above with these characters.

Model[9]. This character is always a "-".

Model[10..12]. These characters indicate the rated optical power output in Watts.

Model[13]. This character indicates the operational modes of the driver.
C: CW operation only
P: CW or QCW (pulsed) operation

Model[14..17]. These characters indicate the optical output target wavelength in nanometers.

Model[18]. This character is always a "-".

Model[19]. This character indicates the number of Q-switch RF outputs provided.
A: a single-output RF output is provided (80MHz, 15W)
B: a dual-output RF driver is provided (80MHz, 30W)
X: no RF driver is utilized

Model[20..22]. These characters indicate the diameter of the output fiber core in microns.

Model[23]. This character is always a "-".

Model[24..27]. These characters are for factory use only.

Model Number Examples

The part number

ED4P-AXW-2037D-0010

indicates that this unit…

…is an eDrive in a 4U enclosure;
…is capable of both CW and QCW operation;
…is water-cooled;
…has a power supply rated for 20V/37A; and
…has a dual-output RF Q-switch driver.

The part number

ED4L-AXA-130C0808-A600-0010

indicates that this unit…

…is an eDrive in a 4U enclosure;
…contains a fiber pump source (eDrive Aero)
…is air-cooled;
…has a 130W optical power output;
…operates in CW mode only;
…delivers output power at 808nm;
…has a single 80MHz, 15W RF output;
…delivers its output into a 600 micron fiber; and
…has a dual-output RF Q-switch driver.

Appendix B:
Connector Interfaces

This appendix contains information on the various connector interfaces present on the eDrive and eDrive Nitro. These connector interfaces include:

- RS-232 Channel 0
- RS-232 Channel 1
- RS-232 Channel 2
- RS-485
- External Sensors (eDrive only)
- Chiller
- CAN Bus
- Q-switch Driver (eDrive only)
- Trigger/Gate In
- Trigger Out
- Current Monitor Out
- Q-switch Interlock (eDrive Nitro/Aero only)
- RF Out 1 & 2 (eDrive Nitro/Aero only)
- Interlock (BNC)
- Interlock (Plastic housing, eDrive Nitro/Aero only)
- Laser Interface (eDrive Nitro/Aero only)
- Fiber Optic Output (eDrive Aero only)
- Ethernet
- Power Supply Input Lugs (some models)
- Array Output Lugs (some models)
- Array Output Connector (some models)
- AC Power Inlet

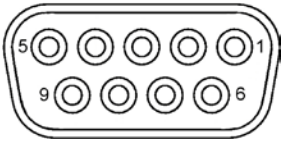
Key:

Type	Meaning
-	No connection
I	Input
O	Output
I/O	Input/Output (Bidirectional)
P	Power
G	Ground/Signal Reference

RS-232 Channel 0, 1

This connector provides a general-purpose RS-232 serial port. It may be used for serial port remote control or in custom applications. Consult factory for options. For RS-232 communications with a standard PC serial port, use a straight-through, male-to-female serial cable. See the appendix, *Accessories*, for ordering information.

Connector type: 9-position D-sub receptacle.

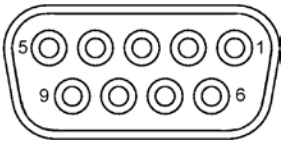


Pin	Name	Type	Function
1	No connection	-	-
2	Transmit Data	O	Serial data output
3	Receive Data	I	Serial data input
4	Data Terminal Ready	I	Reserved
5	Signal Ground	G	Signal reference
6	Data Set Ready	O	Reserved
7	No connection	-	-
8	No connection	-	-
9	No connection	-	-

RS-232 Channel 2

This connector provides a general-purpose RS-232 serial port but is supported for maintenance and custom applications only. Consult factory for options. For RS-232 communications with a standard PC serial port, use a straight-through, male-to-female serial cable. See the appendix, *Accessories*, for ordering information.

Connector type: 9-position D-sub receptacle.

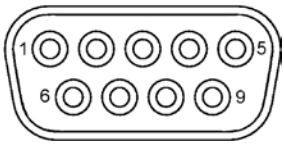


Pin	Name	Type	Function
1	No connection	-	-
2	Transmit Data	O	Serial data output
3	Receive Data	I	Serial data input
4	Reset	I	Reserved for factory test
5	Signal Ground	G	Signal reference
6	No connection	-	-
7	No connection	-	-
8	No connection	-	-
9	No connection	-	-

RS-485

This connector provides a general-purpose RS-485 serial port. It may be used for serial port remote control or in custom applications. In addition to the serial port function, there are two trigger outputs which may be used to trigger external Array Interface Modules (AIM). Consult factory for options.

Connector type: 9-position D-sub plug.

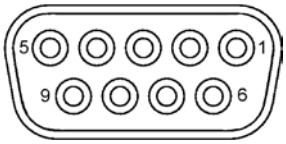


Pin	Name	Type	Function
1	Trigger 1	O	Trigger signal for an external AIM. Active high.
2	Trigger 2	O	Trigger signal for an external AIM. Active high.
3	No connection	-	-
4	Data (-)	I/O	Serial data bus
5	Signal Ground	G	Signal reference
6	Signal Ground	G	Signal reference
7	Signal Ground	G	Signal reference
8	Data (+)	I/O	Serial data bus
9	No connection	-	-

External Sensors (eDrive only)

This connector provides miscellaneous signals that are used in typical laser systems and that may be employed in custom applications. Consult factory for options.

Connector type: 9-position D-sub receptacle.

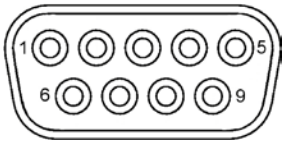


Pin	Name	Type	Function
1	Fused 5V	P	Provides 5V out at up to 1A for external sensors, controls, etc.
2	Ground	G	Signal reference
3	Sensor Bus (+)	I/O	This serial communications bus supports optional sensor and control accessories useful in laser systems.
4	Sensor Bus (-)	G	
5	Laser On Light	O	This ground/open signal is capable of sinking up to 1A and is used to activate a Laser On safety light. This signal mimics the function of the front panel Emission light. Active low. See chapter *Application Examples*.
6	Debug Transmit Data	O	Reserved for factory use.
7	Debug Receive Data	I	Reserved for factory use.
8	Ground	G	Signal reference
9	Shutter Control Output	O	This ground/open signal is capable of sinking up to 1A and is used to activate a shutter control circuit. This output is controlled with the front panel SHUTTER switch. Active low. See chapter *Application Examples*.

Chiller

This connector provides a chiller control interface. Chillers purchased with the eDrive may be connected to this interface for integrated control. The dedicated RS-485 interface provides a communications channel for temperature control. Power control and operational interlocks are also available. Consult factory for options.

Connector type: 9-position D-sub plug.

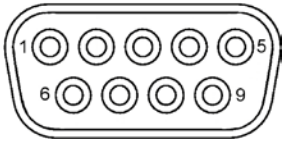


Pin	Name	Type	Function
1	Chiller Flow Interlock	I	This ground/open input indicates to the eDrive that the there is a coolant flow fault. Short to ground for normal operation.
2	Ground	G	Signal reference
3	Chiller Power Control 1	O	This signal, along with Chiller Power Control 2, is used to control the power of the external chiller. This signal along with Power Control 2 provides a dry contact relay output. Max current is 1A. Applied voltage should not exceed 28 VDC.
4	Ground	G	Signal reference
5	Chiller Power Control 2	O	This signal, along with Chiller Power Control 1, is used to control the power of the external chiller. This signal along with Power Control 1 provides a dry contact relay output. Max current is 1A. Applied voltage should not exceed 28 VDC.
6	Data (-)	I/O	Serial data bus for chiller communications.
7	Data (+)	I/O	
8	Chiller Level Interlock	I	This ground/open input indicates to the eDrive that the there is a coolant level fault on the chiller. Short to ground for normal operation.
9	Ground	G	Signal reference

CAN Bus

This connector provides a general-purpose CAN bus serial port but is supported for custom applications only. Consult factory for options.

Connector type: 9-position D-sub plug.

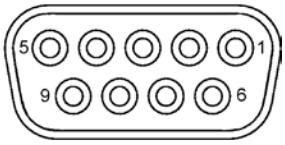


Pin	Name	Type	Function
1	No connection	-	-
2	Data (-)	I/O	Serial data bus
3	Signal Ground	G	Signal reference
4	No connection	-	-
5	No connection	-	-
6	Signal Ground	G	Signal reference
7	Data (+)	I/O	Serial data bus
8	No connection	-	-
9	Fused 5V	O	Provides 5V out at up to 1A

Q-switch Driver (eDrive only)

This connector provides an interface to support an external Q-switch RF driver module.

Connector type: 9-position D-sub receptacle.



Pin	Name	Type	Function
1	Trigger	O	This signal triggers/enables the external RF module to inhibit its RF output in order to allow light to pass through the Q-switch. Active high or low (set by menu).
2	Enable	O	This signal enables external RF module operation. Active high or low (set by menu).
3	First Pulse Suppression	O	This signal triggers the RF driver to begin an amplitude-modulated ramp function to reduce the effective power of the first pulses of a new firing sequence. Active high or low (set by menu).
4	Fault	I	This signal indicates to the eDrive that there is an operational fault with the external RF driver module or Q-switch. Active high or low (set by menu).
5	Q-switch Reset	O	This signal is used to reset Q-switch RF driver fault conditions. Active high or low (set by menu).
6	Ground	G	Signal reference
7	Ground	G	Signal reference
8	Ground	G	Signal reference
9	Ground	G	Signal reference

Trigger/Gate In

This connector provides an interface to support an external pulse trigger input function or gate input function. Refer to *Understanding Driver Functions* for information about using this connector. This signal is active high.

Connector type: BNC.
Input impedance: 50Ω.

Trigger Out

This connector provides an interface to support an external pulse trigger output function. Refer to *Understanding Driver Functions* for information about using this connector. This signal is active high.

Connector type: BNC.

Current Monitor

This connector provides an interface to facilitate measuring the amplitude of the current output. Refer to *Understanding Driver Functions* for information about using this connector. Scale factor for this signal is 10A per volt for 100A eDrives and 20A per volt for 300A eDrives.

Connector type: BNC.

Q-switch Interlock (eDrive Nitro/Aero only)

This connector provides an interface to thermally interlock the Q-switch crystal with the eDrive. Refer to *Understanding Driver Functions* for information about using this connector. The pin and shell must be shorted together for the RF driver to operate.

Connector type: BNC.

RF Out 1 & 2 (eDrive Nitro/Aero only)

These connectors provide RF modulated outputs to the Q-switch crystal(s) inside the laser. Refer to *Understanding Driver Functions* for information about using this connector.

Connector type: BNC.

Interlock (BNC)

This connector provides an interface to interlock the laser system or facility with the eDrive. Refer to *Understanding Driver Functions* for information about using this connector. The pin and shell must be shorted together for the RF driver to operate.

Connector type: BNC.

Interlock (Plastic housing, eDrive Nitro/Aero only)

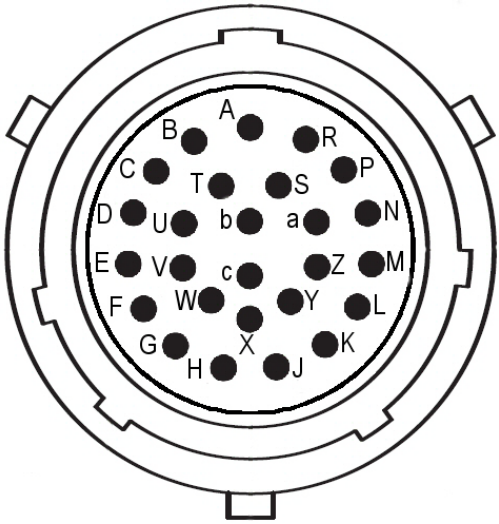
This connector provides an interface to interlock the laser system or facility with the eDrive. Refer to *Understanding Driver Functions* for information about using this connector. The two pins must be shorted together for the RF driver to operate.

Connector type: AMP part 350778-1. (Use mating AMP part 350777-1 and contacts 350689-1.)

Laser Interface (eDrive Nitro/Aero only)

This connector provides an interface to connect the laser system control and monitor signals to the eDrive. Refer to *Understanding Driver Functions* for information about using this connector.

Connector type: MS3472L16-26S. (Use mating connector MS3476L16-26P.)



Pin	Name	Type	Function
A	Laser On Lamp (+)	O	This signal is used to drive an external laser on lamp on the laser housing. Output is 24V. Keep isolated from other circuits. See *Application Examples*.
B	Laser On Lamp (-)	O	
C	Shutter (+)	O	This signal is used to drive an external shutter solenoid in the laser. Output is 24V, pulse width modulated to an average of 12V. It is intended to drive a 12-15V actuator. Output is 24V for a brief energize period and drops to $12V_{avg}$ for continuous duty. See *Application Examples*.
D	Shutter (-)	O	
E	Ground	G	Signal reference
F	RS-485 Data (+)	I/O	Serial data bus. Consult factory for details.
G	RS-485 Data (-)	I/O	
H	Cover Interlock	I	This ground/open signal is used to indicate to the eDrive that the laser enclosure has been opened. Short to ground for normal operation. See *Application Examples*.
J	Coolant Interlock	I	This ground/open signal is used to indicate to the eDrive that the coolant flow inside the laser system is insufficient to continue safe operation. Short to ground for normal operation. See *Application Examples*.
K	Q-switch Thermal Interlock	I	This ground/open signal is used to indicate to the eDrive that the Q-switch crystal is too hot to continue operation. Short to ground for normal operation. See *Application Examples*.
L	Sensor Bus	I/O	This signal is reserved for future use.
M	No connect	-	-
N	No connect	-	-
P	No connect	-	-
R	Ground	G	Signal reference
S	Ground	G	Signal reference
T	+24V	P	+24V power supply output. This signal can supply up to 2A per contact.
U	+24V	P	
V	+5V	P	+5V power supply output. This signal can supply up to 2A.
W	Ground	G	Signal reference
X	Ground	G	Signal reference
Y	+15V		+15V power supply output. This signal can supply up to 100 mA.
Z	-15V		-15V power supply output. This signal can supply up to 100 mA.
a	Ground	G	Signal reference
b	No connect	-	-
c	No connect	-	-

Fiber Laser Output (eDrive Aero only)

This connector provides the output from the fiber pump source. A fiber optic cable should be connected from this Fiber SMA to your laser module.

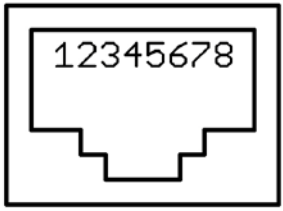
WARNING. Do not attempt to place the eDrive Aero into active emission with no fiber optic cable attached to this connector. Damage to equipment or personnel may result.

DANGER. This connector emits visible and invisible laser radiation. Avoid direct, indirect, or scattered exposure to eyes or skin. Damage to equipment or personnel may result. This is a Class IV laser product.

Connector type: Fiber SMA.

Ethernet

This connector provides an Ethernet interface to connect the eDrive to a network. This interface is only supported when the network support option is purchased. Use a standard straight-through Ethernet cable (EIA/TIA-568A) for connection to a hub or a standard cross-over cable (EIA-TIA-568B) for connection directly to a PC.



Connector type: RJ-45.

Pin	Name	Type
1	Transmit Data (+)	I/O
2	Transmit Data (-)	I/O
3	Receive Data (+)	I/O
4	Unused	-
5	Unused	-
6	Receive Data (-)	I/O
7	Unused	-
8	Unused	-

Power Lugs (select models only)

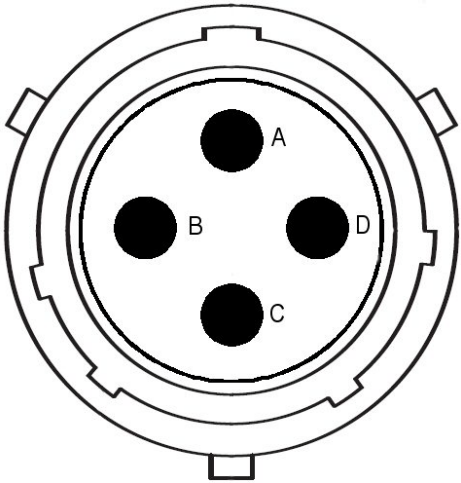
The power lugs are used to connect the eDrive to the external power supply and the laser diode array. To connect leads to these lugs, use 0.25 inch mounting hardware with either ring tongue terminals or two-hole compression lugs. See Getting Started for tips on using these lugs.

CAUTION. Electrical shock hazard. These power lugs can expose dangerous levels of electrical power. Do not touch these terminals unless the eDrive is removed from its power source. Damage to equipment may result. Damage to personnel may result, including death.

Array Output Connector (select models only)

The eDrive may be ordered with an optional circular array power output connector. This connector provides an alternate means of connecting lower-power laser systems to the eDrive without using the power output lugs described above.

Connector type: MS3472L14-4S. (Use mating connector MS3476L14-4P.)

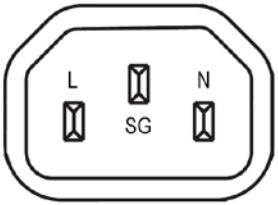


Pin	Name	Type	Function
A	Array Output (+)	O	These contacts provide array power output up to 20A per pin.
B	Array Output (+)	O	
C	Array Output (-)	O	
D	Array Output (-)	O	

AC Power Inlet

This connector provides AC input power to the eDrive. See Getting Started for input power requirements. For 220V/240V operation, the neutral (N) contact becomes a second line contact.

Connector type: IEC 60320, C14.

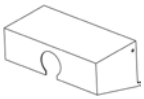


Appendix C: Accessories

This appendix describes the various accessories that are available for the eDrive. All accessories (standard and optional) are available by contacting your local Cutting Edge Optronics sales office.

Standard Accessories

Some of the following accessories come standard with your eDrive.

Picture	Item Number	Description
	88-003-10	AC Power Kit. North American (NEMA 5-15). 120V, 15A, 60Hz. Includes fuses for both 120V and 240V operation.
	88-013-10	Bypass Connector Kit. Use to bypass unused interface connectors and interlocks. Includes three BNC shorting connectors, one interlock shorting connector, and one chiller bypass connector.
	88-023-10	Terminal Shroud. Use to safely cover the output lugs of the eDrive and to terminate the umbilical conduit from the laser system. Includes mounting hardware.
	CEO-UMAN-0001	User Manual. This user manual.
	CEO-UMAN-0013	CD-ROM. The CD-ROM includes the user manual and LabView™ drivers. Additional documentation will be added as it is released.
	88-015-10	Keys. These keys are required to power on the eDrive.

Optional Accessories

The following accessories are not included with your eDrive but can be purchased separately.

Picture	Item Number	Description
	88-004-10	AC Power Kit. Argentina (IRAM 2073:1982). 250V, 10A, 50Hz. Includes new fuses.
	88-005-10	AC Power Kit. Australian (AS/NZS 3112:2000). 250V, 10A, 50Hz. Includes new fuses.
	88-006-10	AC Power Kit. China. 250V, 10A, 50Hz. Includes new fuses.
	88-007-10	AC Power Kit. Continental European (CEE 7/7). 250V, 10A, 50Hz. Includes new fuses.
	88-008-10	AC Power Kit. Denmark (Danish Standard DK-2-1A). 250V, 10A, 50Hz. Includes new fuses.
	88-009-10	AC Power Kit. India/South Africa (BS 546). 250V, 10A, 50Hz. Includes new fuses.
	88-010-10	AC Power Kit. Israel (SI16A3). 250V, 10A, 50Hz. Includes new fuses.
	88-011-10	AC Power Kit. Italy (CEI 23-16/VII). 250V, 10A, 50Hz. Includes new fuses.
	88-012-10	AC Power Kit. Japan (JIS 8303). 125V, 15A, 50Hz. Includes new fuses.

	88-014-10	Bypass Connector Kit (eDrive Nitro). Use to bypass unused laser interface connector interlocks. Includes one laser interface interlock bypass connector.
	88-016-10	Rack Mounting Kit. Recommended for mounting the eDrive series drivers into a standard EIA-310D equipment rack. Includes two mounting rails and mounting hardware.
	88-019-10	Cable Kit 1. Includes: • one 10 foot long BNC interlock cable • one 10 foot long 2-pin interlock cable • one 10 foot long, 10AWG array attachment cable with two-hole compression lugs on the driver end, ring tongue terminals on the laser end • one 6 foot long RS-232 communications cable • one 10 foot long standard Ethernet (EIA/TIA-568A) cable • one 10 foot long chassis grounding cable • mounting hardware
	88-020-10	Cable Kit 2. Includes one 10 foot long, high-performance Litz wire array attachment cable with two-hole compression lugs on the driver end with mounting hardware.
	88-024-xx	Umbilical Conduit. Use this 1.5 inch ID conduit to safely and neatly contain the cabling from the eDrive to your laser system. Specify the length in feet for "xx". For example, 88-024-25 specifies a 25-foot long conduit. Includes two ferrules and nuts.
	88-025-10	Plumbing Kit. Includes two 10 foot long coolant hoses, two 1 foot long coolant hoses, two quick disconnect fitting pairs, and 8 hose clamps.
	88-026-10	External hold-up capacitor kit. Includes one 4700μF electrolytic capacitor, one bleed resistor, one capacitor attachment cable, two capacitor brackets, and mounting hardware. Use this kit to extend the duration of high-current pulses or stabilize undersized or slow power supplies.
	88-021-10	Emergency Stop button (red). Use this button to replace a damaged eDrive button.

Appendix D:
General Care and Cleaning

General Care

Do not store or leave the instrument where it will be exposed to direct sunlight for long periods of time.

CAUTION. To avoid damage to the instrument, do not expose the driver to sprays, liquids, or solvents.

Cleaning

Inspect the instrument as often as operating conditions require. To clean the exterior surfaces, perform the following steps:

1. Turn the system off and disconnect power.
2. Remove loose dust or dirt on the outside of the instrument with a lint-free cloth. Use care to avoid scratching the clear plastic display cover.
3. Disconnect power to the equipment, and clean the exterior of the equipment as needed. Use a soft cloth dampened with water to clean the instrument. Use an aqueous solution of 75% isopropyl alcohol for more efficient cleaning.

CAUTION. To avoid damage to the surface of the instrument, do not use any abrasive or chemical cleaning agents.

Appendix E:
CRC Calculations

This appendix explains the use of a cyclic redundancy check (CRC) in the serial protocol to ensure the integrity of the transmitted data. To help implement this feature in your control software, the following have been provided:

- A description of the algorithm used to generate a CRC
- A flow chart of the algorithm used to generate a CRC
- A code example of the algorithm used to generate a CRC

Overview

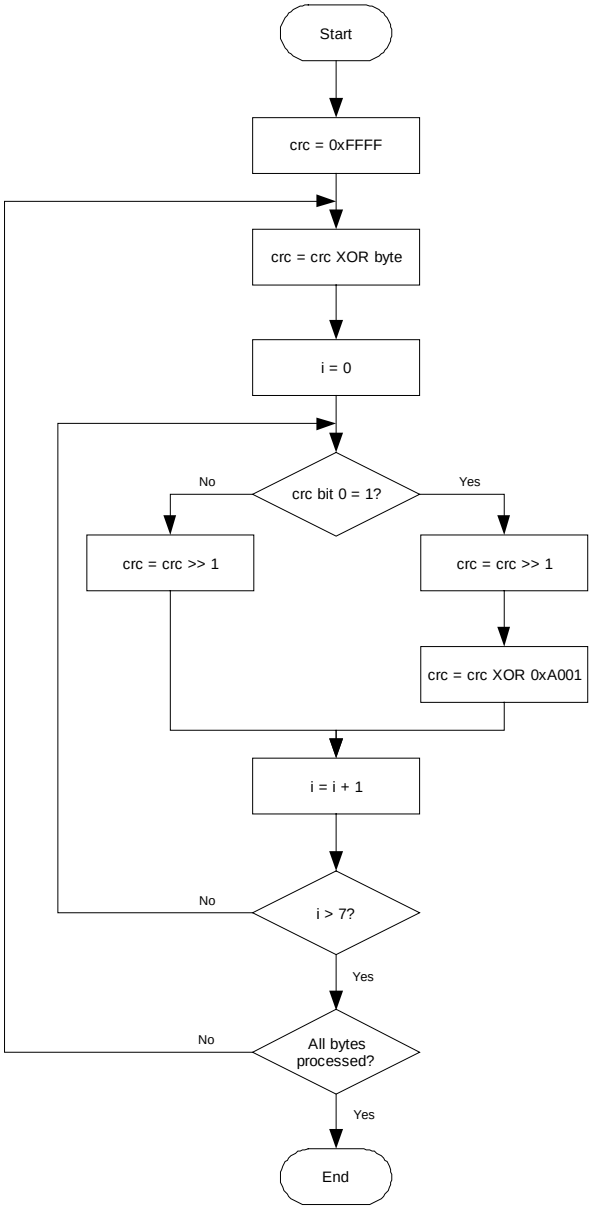
The CRC value is calculated by the master which appends the CRC to the message. The eDrive recalculates a CRC when a message is received and compares the calculated value to the value it received from the master. If the two values are not equal, an error is generated.

Procedural Description

A procedure for generating a CRC follows:

1. Load a 16-bit register with hex value 0xFFFF (0b1111 1111 1111 1111). Call this the CRC register.
2. Exclusive-OR the first 8-bit byte of the message with the low-order byte of the 16-bit CRC register, putting the result in the CRC register.
3. Check the LSB of the CRC register.
    a. If the LSB is 0, shift the CRC register one bit to the right, filling the now-empty most-significant bit (MSB) with 0.
    b. If the LSB is 1, shift the CRC register one bit to the right, filling the now-empty most-significant bit (MSB) with 0. Now exclusive-OR the CRC register with the polynomial hex value 0xA001 (0b1010 0000 0000 0001).
4. Repeat step 3 until eight shifts have been performed. When this is done, a complete 8-bit byte will have been processed.
5. Repeat steps 2 through 4 for the next 8-bit byte of the message until all bytes have been processed.
6. The final contents of the CRC register is the CRC value.

Flowchart


Start
crc = 0xFFFF
crc = crc XOR byte
i = 0
crc bit 0 = 1?
No
Yes
crc = crc >> 1
crc = crc >> 1
crc = crc XOR 0xA001
i = i + 1
i > 7?
No
Yes
All bytes processed?
No
Yes
End

Code Example

The following code example demonstrates the implementation of the algorithm. The code is written in Python. The variable, “string”, is an example string for testing the calculation. The proper result for this string is “3A8C”.

```
string = '\x01\x05\x00\x00\xff\x00'

# initilize the crc and the poly.
crc = 0xFFFF
p16 = 0xA001

for char in string:

  # XOR the next byte with the lower 8 bits of the CRC.
  crc = crc ^ ord(char)

  for bit in range(8):
    if (crc & 0x0001):
      # If the LSB is 1, shift one to the right
      # and XOR 0xA001 with the crc.
      crc = crc >> 1
      crc = crc ^ p16
    else:
      # If the LSB is zero, just shift one to the right.
      crc = crc >> 1

print '%X' % crc

#klc
```

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